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THE MAKING AND FEEDING OF SILAGE.

MAKING AND FEEDING SILAGE . . T. E. Woodward
SILAGE FOR HORSES . . . . . George M. Rommel
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MAKING AND FEEDING SILAGE.

By T. E. Woodward, *of the Dairy Division.*

SOME POINTS IN FAVOR OF SILAGE.

Within the last 30 years silage has come into general use throughout the United States, especially in those regions where the dairy industry has reached its greatest development. Silage is universally recognized as a good and cheap feed for farm stock, and particularly so for cattle and sheep. There are several reasons for the popularity of silage.

1. Silage is the best and cheapest form in which a succulent feed can be provided for winter use.

2. An acre of corn can be placed in the silo at a cost not exceeding that of shocking, husking, grinding, and shredding.

3. Crops can be put into the silo during weather that could not be utilized in making hay or curing fodder; in some localities this is an important consideration.

4. A given amount of corn in the form of silage will produce more milk than the same amount when shocked and dried.

5. There is less waste in feeding silage than in feeding fodder. Good silage properly fed is all consumed.

6. Silage is very palatable.

7. Silage, like other succulent feeds, has a beneficial effect upon the digestive organs.

8. More stock can be kept on a given area of land when silage is the basis of the ration.

Note.—Gives methods and costs of growing and harvesting silage, feeding value, and instructions for filling the silo. Adapted for general circulation. Supersedes Farmers' Bulletin 556.

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9. On account of the smaller cost for labor, silage can be used for supplementing pastures more economically than can soiling crops, unless only a small amount of supplementary feed is required.

10. Converting the corn crop into silage clears the land and leaves it ready for another crop sooner than if the corn is shocked and husked.

Because of these advantages of silage it is the general opinion among dairy farmers who have built silos that the use of silage has increased milk production per cow and has increased the profits per acre, though it is no doubt true that in certain localities which are well adapted to the growth of alfalfa or other hays of good quality, the same amount of food nutrients may be produced at less cost in the form of hay than as silage.

SILAGE CROPS.

Almost any green crop can be successfully made into silage if sufficient care is taken to force out the air from the material. On account of the difficulty, however, of expelling air from plants with a hollow stem, such as timothy, oats, and barley, these crops are rarely put into the silo.

CORN.

In all parts of the United States where the silo has come into general use the principal silage crop is corn. One reason for this is that ordinarily corn will produce more food material to the acre than any other crop which can be grown. It is more easily harvested and put into the silo than any of the hay crops, such as clover, cowpeas, or alfalfa. With the harvesting machinery which we have at the present time these crops are much more difficult to handle after being cut. Furthermore, corn makes an excellent quality of silage. The legumes, such as clover and alfalfa, are liable to rot unless special care is taken to pack the silage thoroughly and force the air out.

The only objection which has been raised concerning corn silage is the fact that it contains insufficient protein fully to meet the requirements of animals to which it may be fed. Some persons have advised mixing clover, cowpeas, or alfalfa with the corn when filling the silo in order to correct this deficiency of protein. Such a procedure is not to be advised, however, if it is possible to cure the clover or other crop into hay, which usually can be done if hay caps are used. Since some dry forage should always be fed with the silage, it is better to use the leguminous hay in this way rather than to convert the crop into silage.

VARIETY TO PLANT.

The best variety of corn to plant is that which will mature and yield the largest amount of grain to the acre, since the grain is the

ost valuable part of the corn plant. The variety commonly raised any particular locality for grain will also be the most satisfactory grow for silage. As will be seen from the table below, taken from e First Annual Report of the Pennsylvania State College, 63 per nt of the digestible food materials present in the corn plant are und in the ears and 37 per cent in the stover.

Yield of digestible matter in corn.

Constituent.	Yield per acre.		
	Ears.	Stover.	Total crop.
	Pounds.	*Pounds.*	*Pounds.*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

FIG. 1.—A field of good corn.

CULTIVATION AND YIELD.

n some sections it is a common practice to plant the corn a little ker when raised for silage than for grain. Weeds should be t out, or they will be cut with the corn and may impair the quality the silage. The amount of silage that can be obtained from an e of corn will vary from 4 to 20 tons or more. A 50-bushel per

acre crop of corn will yield about 8 to 12 tons of silage per acre, depending upon the amount of foliage and stalk that accompanies the ear. Southern varieties of corn as a rule carry a larger proportion of the plant in the form of stalk and leaves than do the northern-grown varieties.

TIME TO HARVEST.

Corn should be harvested for the silo at about the same time that it is harvested for fodder—that is, when the grain has become glazed and the lower leaves of the stalk have turned brown. The following table taken from the Eighth Annual Report of the New York Experiment Station will furnish valuable information as to the proper time to cut corn for the silo:

Chemical changes during growth of corn plant.

Yield per acre.	Stage of growth.				
	Tasseled July 30.	Silked Aug. 9.	Milk Aug. 21.	Glazed Sept. 7.	Ripe Sept. 23.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Total yield	18,045	25,745	32,600	32,295	28,460
Water	16,426	22,666	27,957	25,093	20,542
Dry matter	1,619	3,078	4,643	7,202	7,918
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

The table shows that there is a steady increase in the amount of dry matter and food ingredients in the corn plant up to the time it is ripe. This indicates very plainly that immature corn is inferior to mature corn, whether fed fresh or as silage.

Silage made from immature corn is not only less nutritious but also more acid than that made from more mature corn. The corn should not be allowed to become thoroughly ripe and dry, however, because the stalk and foliage are rendered more difficult to digest, and, besides, the corn can not be packed into the silo tightly enough to prevent "fire-fanging" without using excessive amounts of water. In case the corn is frozen before it is properly matured for cutting, it should be harvested at once before it has had time to dry out to any great extent. Enough water should be added to replace that lost by evaporation through standing in the field after frosting.

SORGHUMS.

Sorghums, both saccharine and nonsaccharine, are readily made into silage. On account of their superiority to corn as drought-resistant crops they are more dependable and yield more in those

regions of the West where the rainfall is too light or irregular for a good growth of corn. The Kansas station reports in Circular 28 that if the sorghums are harvested at the proper stage of maturity—that is, when the seed has become hard—they will make silage which is less acid and more palatable than silage made from corn. Furthermore, its experiments indicate that there is little difference in the feeding values of these silages. It is all-important that the sorghums be harvested at the proper stage of maturity if the best results are to be secured. A mixture of corn and sorghum has proved satisfactory in some localities where the rainfall was so variable as to make the corn crop uncertain.

CLOVER.

Clover is a successful silage crop yielding a palatable product high in protein. The silage made from clover as from other legumes has an objectionable odor, necessitating particular care in feeding to avoid tainting the milk. It does not pack so well as corn, so great care should be exercised in the tramping of the silage at the time of filling, and the depth of the silo should also receive particular attention. A shallow silo will not prove satisfactory. Clover should be chopped before siloing as a matter of convenience in feeding and also to secure more thorough packing, although it can be placed in the silo without chopping. Clover should be harvested at the same time as for making into hay—that is, when in full bloom and some of the first heads are dead. As stated elsewhere, it is usually inadvisable to make clover into silage if it can be made into hay, as is the case under most conditions. It is better practice to raise corn for silage and use the clover in the form of hay as a supplement to the silage.

COWPEAS, ALFALFA, AND SOY BEANS.

All these crops can be successfully made into silage by exercising the same precautions as with clover. They should be cut at the same time as for haymaking. However, it is ordinarily preferable, as with clover, to make them into hay rather than silage. The fermentations which take place in silage made of legumes cause a greater loss of nutritive material than with corn silage.

Corn husks and pea vines from canning factories, beet pulp and other by-products are also used in certain localities for filling the silo.

HARVESTING THE CROP AND FILLING THE SILO.

HARVESTING THE CORN.

Corn for the silo can be cut either by hand or by machine. Hand cutting is practiced on farms where the amount of corn to be harvested is so small as to make the expense of purchasing a corn har-

vester too great to justify its use. Hand cutting is also resorted to through necessity when the corn is down or lodged in such a manner as to prevent the use of the machine. This method of cutting, however, is slow and laborious and there are probably few localities now where the purchase of a harvester would not be a profitable investment. In case the expense is considered too great to be borne by one farmer, two or more could advantageously purchase a machine together.

In using the harvester it will be found a great advantage to make the bundles rather small. This will take more twine, but the extra expense will be more than offset by the ease of handling the bundles

FIG. 2.—Corn harvester at work.

and in feeding them into the silage cutter. Two or three horses, preferably three, and one man will be required to run the harvester, and they should be able to cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will dry out to any considerable extent. (See fig. 2.)

HAULING TO THE CUTTER.

This is ordinarily done with the common flat hay frames. An objection to their use is that it is necessary to lift the green corn fodder to a considerable height in loading, which is hard work. A

low-wheeled wagon is preferable to a high-wheeled one. A low-down rack quite commonly used in some parts of the United States can be easily made. (See fig. 3.) The following are the directions for making this rack, taken from Farmers' Bulletin 292:

The rack * * * consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

The load should be as large as possible, especially when the haul is for some distance. This is a matter which rarely receives sufficient attention by persons filling silos, and in consequence the expense of filling becomes unnecessarily high.

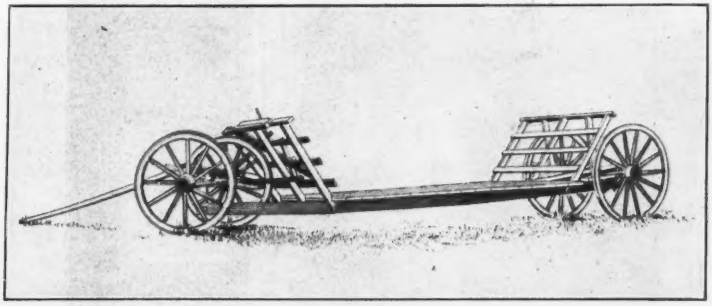

FIG. 3.—A low-down rack suitable for hauling corn to cutter.

CUTTING THE SILAGE.

THE CUTTER.

There are on the market several makes of silage cutters that will give satisfaction. The capacity of the machine to be purchased is an important consideration which should not be overlooked. Many persons make the mistake of getting a cutter which is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that every one will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available. Of course, for the filling of a very small silo it would not be wise to buy a large machine. Neither would it be advisable to overload the engine or motor by using a cutter which is too large for the power available.

THE ELEVATOR.

Two types of elevators are in use—the old-style chain carrier and the blower. (See fig. 4.) The chain carrier requires less power, but is harder to set up and there is more litter around when it is used, especially in windy weather. For these reasons the blower is now fast displacing the carrier.

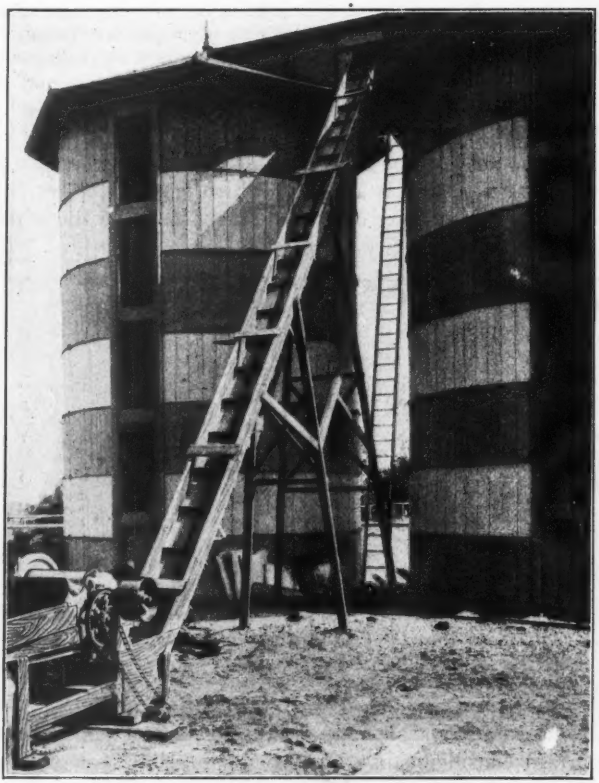

FIG. 4.—Silage cutter with chain carrier.

The blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and lessen the danger of clogging. (See fig. 5.)

POWER REQUIRED.

The power necessary to operate the cutter will depend upon its size and whether the elevator is a chain carrier or a blower and upon the rate of feeding. It is possible to feed slowly and to get along with less power than would be required with full feeding.

As a rule, however, a person should have power sufficient to run the cutter at full capacity, and even a little surplus is advisable. The power required for a cutter and blower, if a gasoline engine is used, is about 1 horsepower for each 1-inch length in the cutting cylinder; that is, a 15-inch cutter will take a 15-horsepower engine, an 18-inch cutter will require an 18-horsepower engine, and so on. If a steam

FIG. 5.—Silage cutter with blower.

engine is employed, the power should be at least two-thirds of that indicated for the gasoline engine.

LENGTH TO CUT.

The usual length of cutting varies from one-half to 1 inch. The latter is considered a little too long, since pieces of this length will neither pack so closely in the silo nor be so completely consumed when fed as will the shorter lengths. On the other hand, the longer the pieces the more rapidly can the corn be run through the cutter.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn into the top of the silo and there are one or more men in the silo to distribute and tramp the material. Unless there is some one to do this the cut material will be thrown too much in one place and the leaves, stalks, and grain will not be uniformly distributed throughout the silo. The sides should be kept higher than the center, and the whole surface kept well tramped. Much of the tramping should be done close to the wall.

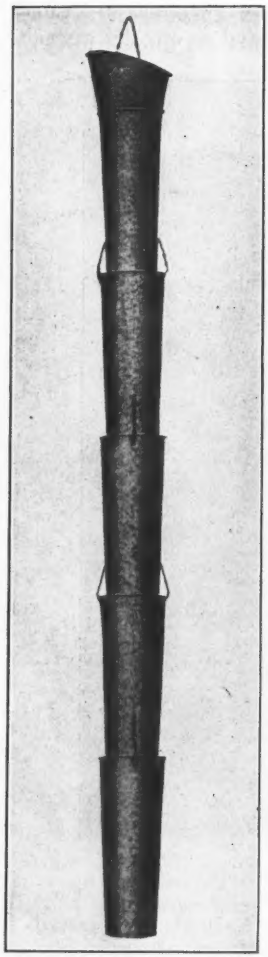

FIG. 6.—Jointed-pipe silage distributor.

Various contrivances have been used for distributing the silage. The one commonly recommended for this purpose, however, is a metal pipe similar to the one in which the cut corn is elevated, but put together loosely in sections. The corn from the blower passes down this pipe into the silo, and being loosely put together it can be swung so that the material can be placed anywhere in the silo. (See fig. 6.) With this contrivance no work with a fork is necessary and one man can do the work of two or three and do it more easily. There is very little loose material flying about in the silo and the work is much cleaner. Another advantage is a lessening of the danger of being struck by some foreign object which might pass up the blower pipe. Heavy knives of the cutter have been known to pass through the blower and into the silo. As has been mentioned, this pipe is put together in sections, so that as the silage rises in the silo the sections can be readily detached as required.

ADDING WATER.

In case the material has become too dry before it is put into the silo, water should be added to supply the deficiency of moisture necessary to make the silage pack properly. Unless it is well packed the silage will "fire-fang" or deteriorate through the growth of mold. Enough water should be added to

restore the moisture content of the corn to what it would be if cut at the proper stage. The water may be added by running directly into the silo by means of a hose or by running through the blower. It is claimed that by running it into the blower the water is more thoroughly mixed with the cut corn.

It seems to be good practice, no matter what the condition of the corn is, to wet down the material thoroughly at the top of the silo when through filling. This will help to pack the top layer and lessen the amount of spoiled silage on top.

COVERING THE SILAGE.

Several years ago it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. At present when any provision at all is made for this purpose it consists usually in merely running in on top cornstalks from which the ears have been removed. By this method some of the corn grain is saved. The heavy green cornstalks pack much better than straw does and so exclude the air more effectually. The top is thoroughly tramped and then wet down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass will cause the oats to sprout quickly and form a dense sod which serves to shut off the air from the silage beneath, and in consequence only a very shallow layer spoils. Whenever possible, it is better to begin feeding from the silo as soon as it is filled; by doing this no covering is necessary and there should be no loss on account of spoiling.

LABOR AND TEAMS REQUIRED.

The labor and teams to be used will of course depend upon the help available, the length of haul, and the efficiency of the machinery. With plenty of help, a short haul, and good machinery the following distribution of labor might well be used:

1 man and 3 horses to bind the corn.
3 or 4 men to load the corn.
3 men and 6 horses to haul.
1 man to help unload.
1 man to feed the cutter.
1 or 2 men to work in the silo.
1 man to tend the engine, if steam engine is used.
Total, 11 to 13 men, 9 horses, and 3 wagons.

The least amount of help which it would be possible to work to advantage might be arranged as follows:

1 man and 2 horses to bind the corn.
2 men to help teamsters load.
2 men and 4 horses to haul and unload.
1 man to feed.
1 man in the silo.
Total, 7 men, 6 horses, and 2 wagons.

A good manager is required to arrange the help so that each man and team can do the most efficient work. Without careful attention to this matter the operation of filling the silo becomes needlessly expensive.

COST OF HARVESTING AND FILLING.

It is not possible to set any definite figure as the cost of filling the silo because of the great variation in conditions in different parts of the country. But in order to give some idea of the probable cost a few figures are taken from Farmers' Bulletin 292. The investigation reported in this bulletin included the work done upon 31 farms in Wisconsin and Michigan. The labor of each man was rated at 15 cents per hour and the same value placed upon each team of two horses. Engine hire was estimated at $4.50 per day, including the engineer. Twine was rated at 11½ cents a pound, coal at $5 a ton, and gasoline at 13 cents a gallon. The farmers owned the cutters. In this investigation the cost per ton varied from 46 to 86 cents.

Investigations conducted by the Dairy Division during the past few years with 87 silos in various parts of the United States indicate the cost of filling to be an average of 87 cents per ton. This does not include interest on investment nor depreciation of machinery or silos.

COOPERATION IN SILO FILLING.

The high cost of silo-filling machinery makes it oftentimes advisable for several farmers to cooperate in the purchase of a cutter and engine, or at least a cutter, since an engine is more easily rented than a cutter. By varying the time of planting in the spring each man can get his silo filled when the corn is at the proper stage of maturity. Besides this the farmers can help one another in filling, so that there need be a very small cash outlay.

TOTAL COST OF SILAGE.

As with the cost of filling the silo, no definite figure can be set as to the cost of silage. This will depend upon the yield per acre, the cost of growing an acre, and the cost of filling. Several years ago the cost was variously estimated at from $1 to $1.50 per ton. At present this is much too low. The aforesaid data collected by the Dairy Division on the filling of 87 silos in various parts of the country show the cost of growing the silage crop to average $1.58 per ton. This includes interest on investment in land or rental price, as the case may be, but does not include interest on the cost of equipment nor the depreciation of the equipment. This $1.58 added to the 87 cents, which represents the cost of filling, makes the total cost of the silage $2.45 per ton. The cost of the silage for the individual farms varied from $1.10 to $5.42 per ton. In general, it

may be stated that $1.50 to $4 per ton represents the limits between which most of the silage is produced.

LOSSES OF FOOD MATERIAL IN THE SILO.

When any crop is made into silage certain fermentation takes place, which results in the production of a considerable amount of heat and the consequent loss of food material. The extent of this fermentation is dependent upon the amount of air in the silo. The more air there is present the higher will be the temperature of fermentation and the greater the loss of food ingredients. Fermentation will continue until all the oxygen of the air has been used up or has been displaced by carbon dioxid. In the deep silos of the present time the pressure is so great that very little air is left in the silo; consequently the losses of food ingredients are reduced to a minimum. As before mentioned, on account of the difficulty of pressing out this air in crops with a hollow stem, they are seldom put in the silo.

Some experiments conducted at the Wisconsin station show that the losses in the siloing of corn are not nearly so great as in the field curing of corn fodder. According to Prof. Woll, in modern, well-built, deep silos the loss should not exceed 10 per cent. More food material can be saved by putting the corn crop into the silo than by harvesting and storing it in any other way.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and nutritive value of silage will vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in the following table, taken from Henry's "Feeds and Feeding," show the average amount of digestible nutrients in 100 pounds of silage and other succulent feeds:

Crop.	Total dry matter.	Digestible dry matter.		
		Protein.	Carbohydrates.	Fat.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Green fodder corn	20.7	1.0	12.2	0.4
Corn silage	26.4	1.4	14.2	.7
Green sorghum fodder	20.6	.6	11.6	.3
Sorghum silage	23.9	.1	13.5	.2
Uncured red clover	29.2	2.9	13.6	.7
Clover silage	28.0	1.5	9.2	.5
Uncured soy bean	24.9	3.1	11.0	.5
Soy-bean silage	25.8	2.7	9.6	1.3
Uncured cowpeas	16.4	1.8	8.7	.2
Cowpea vine silage	20.7	1.5	8.6	.9
Pasture grass	20.0	2.5	10.1	.5
Oats and peas (uncured)	20.3	1.8	10.2	.4
Mangels	9.1	1.0	5.5	.2
Sugar beets	13.5	1.3	9.8	.1
Sugar-beet pulp (wet)	10.2	.5	7.7	.....
Prickly pear	15.8	.4	6.2	.2

It will be observed that about three-fourths of the total weight of silage consists of water. It will also be noticed that both corn and sorghum contain a large amount of carbohydrates in proportion to the protein. Silage is a bulky, succulent feed with a wide nutritive ratio, and for these reasons it will give the best results when fed with some other feed richer in dry matter and in protein.

SUCCULENCE.

In feeding cattle it is quite important that the ration include some succulent material, such as fresh grass, root crops, or silage. A feed containing a large amount of water in the form of natural plant juices is not only more easily digested but is also more palatable and, besides, serves the useful purpose of keeping the whole system of the animal in good condition. A silage-fed animal is rarely troubled with constipation or other digestive disturbances, the coat is noticeably sleek and soft, and the skin is soft and pliable. It is a well-known fact that a cow usually reaches her maximum production when she has access to a good pasture. The best and cheapest substitute for fresh pasture grass during the fall and winter is silage.

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a cow will not eat silage readily until she has acquired a taste for it; this may require several days. But silage is not peculiar in this respect, for it has been observed that range horses or cattle shipped into the corn belt refuse corn the first time it is offered to them. The quality of palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

Silage has been found to be particularly well adapted as a feed for dairy cows and as a consequence silos are more numerous upon farms devoted to dairying than upon any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains insufficient protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpeas, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. A ration of silage and, say, alfalfa hay alone is satisfactory, however, only for

cows which are dry or giving only a small amount of milk and for heifers and bulls. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

AMOUNT TO FEED.

The amount of silage to feed a cow will depend upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed along with her hay and grain. Raise or lower the amount until the proper quantity is ascertained. Generally speaking, a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The small breeds will eat 25 or 30 pounds per day; the large breeds 40 or more; and the medium-sized ones amounts varying between.

RATIONS.

Ironclad directions for feeding cows can not be given. In general, however, they should be supplied with all the roughage they will clean up with grain in proportion to butterfat produced. The hay will ordinarily range between 5 and 12 pounds per cow per day when fed in connection with silage. For Holsteins 1 pound of concentrates for each 4 pounds of milk produced will prove about right. For Jerseys 1 pound for each 3 pounds of milk or less will come nearer meeting the requirements. The grain for other breeds will vary between these two according to the quality of milk produced. A good rule is to feed seven times as much grain as there is butterfat produced.

The following rations have been found satisfactory:

For a 1,300-pound cow yielding 40 pounds of milk testing 3.5 per cent:

	Pounds.
Silage	40
Clover, cowpea, or alfalfa hay	10
Grain mixture	10

For the same cow yielding 20 pounds of 3.5 per cent milk:

	Pounds.
Silage	40
Clover, cowpea, or alfalfa hay	5
Grain mixture	5

For a 900-pound cow yielding 30 pounds of 5 per cent milk:

	Pounds.
Silage	30
Clover, cowpea, or alfalfa hay	10
Grain mixture	11

For the same cow yielding 15 pounds of 5 per cent milk:

	Pounds.
Silage	30
Clover, cowpea, or alfalfa hay	8
Grain mixture	5

A good grain mixture to be used in a ration which includes silage and some sort of leguminous hay is composed of—

	Parts.
Corn chop	4
Wheat bran	2
Linseed-oil meal or cottonseed meal	1

In case the hay used is not of this kind some of the corn chop may be replaced by linseed or cottonseed meal. In many instances brewers' dried grains or crushed oats may be profitably substituted for the bran, and oftentimes gluten products can be used to advantage in place of bran or oil meals.

TIME TO FEED.

The time to feed silage is directly after milking or at least several hours before milking. If fed immediately before milking the silage odors may pass through the cow's body into the milk. Besides, the milk may receive some taints directly from the stable air. On the other hand, if feeding is done subsequent to milking, the volatile silage odors will have been thrown off before the next milking hour. Silage is usually fed twice a day.

Many objections have been made to the feeding of silage, some condenseries even refusing to let their patrons use it. These objections are becoming less common, since milk from cows fed silage in a proper manner is in no way impaired; furthermore there is nothing about silage that will impair the health of the animals.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before feeding. If it is then given immediately to the cows before decomposition sets in no harm will result from feeding this kind of silage; neither is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be fed silage as soon as they are old enough to eat it. It is perhaps of greater importance that the silage be free from mold or decay when given to calves than when given to mature stock. They may be given at all times all the silage they will eat up clean. Yearling calves will consume about one-half as much as mature stock; that is, from 15 to 20 or more pounds a day. When supplemented with some good leguminous hay, little, if any, grain will be required to keep the calves in a thrifty, growing condition.

There is a decided opinion among some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Pending further investigations, however, it is advisable to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this amount silage is thought to be a good, cheap, and safe feed for bulls. It should of course be supplemented with hay, and with a small allowance of grain also in the case of bulls doing active service or growing rapidly.

Cows when dry will consume almost as much roughage as when they are milked. Silage may well form the principal ingredient of the ration; in fact, with 25 to 40 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay, say 5 to 6 pounds a day, the cows will keep in good flesh and even make some gain. Cows in thin flesh should receive in addition a small amount of grain. Silage will tend to keep the whole system in good condition and in this way lessen the troubles incident to parturition.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for the dairy cow is the latter part of summer and early fall. At this season the pastures are often short or dried up, and in such cases it is a common mistake of dairymen to let their cows drop off in flow of milk through lack of feed. Later they find it impossible to restore the milk flow, no matter how the cows are fed. Good dairy practice demands that the milk flow be maintained at a high level all the time from parturition to drying off. It becomes necessary, therefore, to supply some feed to take the place of the grass. The easiest way to do this is by means of silage. Silage is cheaper and decidedly more convenient to use than soiling crops.

The amounts to feed will depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed of 40 pounds. It should be remembered in this connection that silage contains a low percentage of protein, so that the greater the amount of silage fed the greater must be the amount of protein in the supplementary feeds to properly balance the ration.

SILAGE FOR HORSES.

By GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been generally fed to horses, partly on account of a certain amount of danger which attends its use for this purpose, but still more, perhaps, on account of prejudice. In many cases horses

have been killed by eating moldy silage, and the careless person who fed it at once blamed the silage itself, rather than his own carelessness and the mold which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions certain molds grow on silage which are deadly poisons to both horses and mules. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather warms up he can soon detect the presence of mold. When mold appears, feeding to horses or mules should stop immediately.

It is also unsafe to feed horses frozen silage on account of the danger of colic. This is practically impossible to avoid in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be vigorously tramped and packed while filling. At least three men should be inside the silo, moving constantly, two around the edges and the third across and around the center. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is likely to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which might be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter season cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it, and the daily consumption is so large as to preclude the formation of mold on the surface.

To cheapen the ration of brood mares in winter no feed has more value than good corn silage. If the grain goes into the silo with the stover no additional grain is needed for brood mares, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the

grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Mares fed in this manner will be in splendid condition for foaling, and, so far as the writer's experience goes, the foals will be fully as vigorous, with just as much size and bone, as if the mares were fed the conventional grain and hay ration.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases where stallions receive a ration of silage, but has had no experience in feeding them in this manner. There seems no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should also be useful for young horses, especially drafters, but here again the writer can not quote his own experience and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn, properly stored in the silo. When it is properly stored and is not allowed to mold, no feed exceeds it as a cheap winter ration. It is most valuable for horses and mules which are not at heavy work, such as brood mares and work horses during the slack season. With plenty of grain on the cornstalks, horses will keep in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

By W. F. Ward, *Animal Husbandman in Beef Cattle Investigations.*

There is no roughage which is of more importance to the producer of beef cattle than silage. The value of silage to the beef producer varies considerably and is dependent upon a large number of other factors. If rough fodders are scarce or are high priced, if the grain is high priced, or if the grain is not near a good market that much of it can be readily sold, silage will have a greater value than if the opposite conditions exist. It is a great saver of grain regardless of whether it is to be fed to stock cattle or fattening cattle. It will lessen the grain feeding by practically the same amount as is contained in the silage. The value will also depend somewhat upon the kind of cattle to which it is to be fed. If there is an abundance of rough fodders which can not be marketed, silage will not be so val-

uable. But in a case of this kind the silage would prove more valuable if used for the calves and pregnant cows and the coarse fodders used for the other stock.

SILAGE FOR THE BREEDING HERD.

For wintering the entire breeding herd there is no roughage better than silage. All of the animals will relish a ration containing it and it will create a good appetite for all other feeds. Cows that are fed all of the silage they will consume along with clover hay will go through the winter in fine shape and make small gains. If the amount of silage is limited, a more economical method of wintering them will be to reduce the silage to a half ration, letting them have the run of a straw stack and feeding about 2 pounds of cottonseed meal or oil meal per day. Some dry coarse fodder or straw should always be kept before animals getting silage, as it reduces the amount of silage consumed and prevents the bowels from becoming too loose. The succulent feed will cause the breeding cows to give a good flow of milk even though the calf be born in midwinter, and a thrifty calf will result. If the silage is free from mold or rotten spots there will be no danger in feeding it to breeding cows.

Silage is especially beneficial for calves which have just been weaned. They take to this ration quicker than to dry feed and there is usually little loss in weight from the weaning. The silage should be supplemented with some good leguminous hay, as alfalfa, cowpea, or clover, and the calves should be given a small amount of grain. A mixture of one-half corn chop and one-half cottonseed meal is excellent.

SILAGE FOR STOCKERS.

Each farmer will have to plan the rations for his cattle according to the amount of the various feeds he has on hand. Stockers can be wintered on silage and some good hay, fodder, or straw, but this may not always be the most profitable. When hay is high priced and grain is reasonably cheap or plenty of silage is available, it may be more economical to omit the hay altogether. A ration of corn silage alone has often been profitable for thin cattle. Stockers which have been fed liberally all winter and made to put on good gains usually do not make as large daily gains when put on grass as do steers which have not been quite so well fed. The time the cattle are to be finished for market and the degree of fatness to be attained should govern to a large extent the method to be followed during the winter. When beeves are expected to sell high in the early summer and the steers are to be finished for market at that time, a heavy roughage ration with a small amount of grain should be fed during the winter months.

SILAGE FOR FATTENING ANIMALS.

Silage stands first in rank of all the roughages for finishing cattle. Formerly, during the era of cheap corn and other concentrates little attention was given to the roughage, as it was usually considered merely a "filler" and of very little economic value in feeding. No especial care was taken in selecting any particular kind, nor was the quality of it seriously considered. As the prices of the concentrated feedstuffs advanced, the feeder looked about for methods of cheapening the cost of producing beef, and soon found this could be accomplished by using judgment in selecting his roughage with respect to the grain fed. This has continued until at the present time the roughage receives as much attention as the concentrated feed, and has been made to take the place of a large amount of the latter. The feeding of silage came into general use with the advent of expensive grain and is becoming more popular each year. With the present prices of feedstuffs there is hardly a ration used for feeding cattle which can not be cheapened by the use of this succulent feed. By combining it with other feeds the efficiency of the ration is increased to such an extent that the amount of the daily gains is invariably greater and the cost of producing a pound of gain is lessened. The heaviest daily gains are usually made during the first stage of the feeding period, and silage can then be used to advantage in large quantities with a small amount of grain, but as the feeding progresses the amount of silage should be lessened and the grain increased. In some places the price of hay and stover is so high that the greater the proportion of silage used in the ration the more profitable is the feeding.

Conditions in general are such that any given ration will not suit a large number of farmers, nor will it be so profitable for some as it will for others, so each farmer must determine for himself just what combination of feeds will be most profitable for his use. However, to give a general idea of some of the rations adapted to different localities and which may prove satisfactory for a 1,000-pound steer, some examples are given below:

RATIONS.

FOR THE CORN BELT.

Ration 1.

	Pounds.
Corn silage	25
Corn stover	6
Cottonseed meal or oil meal	3
Shelled corn	14

Ration 2.

Corn silage	25
Clover hay	7
Shelled corn	15

FOR THE EASTERN STATES WHERE HAY IS VERY HIGH AND CORN IS RELATIVELY HIGH.

	Pounds.
Corn silage	30
Corn stover	6
Cottonseed meal or oil meal	4
Shelled corn	10

FOR THE SOUTH WHERE COTTONSEED MEAL IS OF MODERATE PRICE AND COWPEA HAY IS RAISED ON THE FARM.

Ration 1.

	Pounds.
Corn silage	35
Cowpea hay	8
Cottonseed meal or oil meal	7

Ration 2.

Corn silage	30
Cottonseed hulls	12
Cottonseed meal	7

FOR THE WEST WHERE CORN CAN NOT BE RAISED.

Ration 1.

	Pounds.
Kafir-corn silage	30
Prairie hay	3
Cottonseed meal	3
Kafir-corn meal	10

Ration 2.

Kafir-corn silage	25
Alfalfa	7
Kafir corn	15

It should be understood that the above rations are not necessarily to be fed in the exact quantities given above, but should be modified to suit local conditions or the actual conditions on each farm. They are given to show approximately the average amounts and character of feed that would be consumed daily by a 1,000-pound steer during the feeding period.

It is well to feed as near a balanced ration as possible without materially increasing its cost. Sometimes the prices of available feeds are such that a farmer is justified in deviating from the standard. Such conditions are illustrated by the use of some of the rations given above. The second ration shown for the South is an example, as that ration is very narrow, but in certain localities it is more profitable than one which is balanced by the use of high-priced carbohydrate feeds.

Two rations are shown for the West where kafir-corn silage is used. With some farmers it would undoubtedly be more profitable to use alfalfa hay as a substitute for cottonseed meal, while with others the purchase of the cottonseed meal would be more economical.

MISCELLANEOUS CONSIDERATIONS.

Silage is a quick finishing roughage in that it produces large daily gains and produces a glossy coat and a soft, pliable skin. Moreover, it can be used to advantage at times for carrying cattle for a longer time so as to pass over a period of depression in the market, or to carry the cattle along in thrifty condition so they can be finished at a later period.

For many years the belief was general that cattle which received silage as a major portion of the roughage would have to be kept in warm barns and not exposed to the cold. While they do need protection from the cold winds and rains and need a dry place to lie down, it has been clearly demonstrated that warm barns are not only unnecessary, but that fattened cattle make both larger and cheaper gains when fed in the open sheds than when confined in barns. Stocker or thin cattle receiving silage will, of course, need more protection than animals which are being fattened.

Silage can be profitably used to supplement the pastures for steers during a time of drought, when they are being finished for market, but it is still an open question whether it can always be used profitably for feeding to breeding cattle during such times.

The theory that silage-fed cattle shrink very heavily in shipping to market is erroneous. While the actual shrinkage during transit is sometimes greater, the fill taken at market is usually good, and if good judgment is used in preparing them for shipping the net shrinkage is no greater than for cattle which have been fed on dry feeds. For 36 hours previous to shipping nice bright hay and stover should be substituted for the silage in the ration.

The general impression that choice or prime carcasses can not be made by the use of succulent feed is equally untrue, as the silage-fed cattle usually make more desirable carcasses than cattle fed a similar ration, except that silage was replaced by one of the coarse fodders. There is no appreciable difference in the percentage of marketable meat that steers will dress out which have been finished on a silage ration and a dry ration. The meat seems equally bright and the fat as well intermixed with the lean.

If silage makes up the bulk of the roughage it will be necessary to haul large amounts of bedding into the sheds to keep the animals dry, as there is no waste in silage, or else make a cement floor and cover with bedding to absorb the urine and prevent the animals from slipping and to give them a warm place to lie down. When the enormous saving in the quality and amount of the feed is considered, this disadvantage does not seem so hard to overcome by the stockman who has the capital to put up the silo and pave his feed sheds or feed lots.

SILAGE FOR SHEEP.

By E. L. SHAW, *Animal Husbandman in Sheep and Goat Investigations.*

The use of this succulent feed for sheep has attracted the attention of most farmers only during the past few years. Although a few sheepmen fed silage many years ago with good results, most flockmasters have been slow in giving it a trial. Owing to the wonderful increase in the use of silos on farms, and owing to the cheapness of silage as compared with other succulent feeds, such as roots, farmers are constantly raising the question regarding the feeding of silage to sheep. A great deal has been said of its bad effects upon sheep, but these have arisen either because an inferior quality of silage was fed or on account of carelessness on the part of the feeder in not feeding it properly.

A good quality of silage is extremely palatable and can be fed to all classes of sheep with good results. It must be borne in mind, however, that silage which is either very sour, moldy, or frozen should not be fed.

The amount of silage reported in feeding trials varies from 1 to 5 pounds per head per day. The amount to feed depends upon the class of sheep and the character of the other feeds comprising the ration. As a general rule from 2 to 4 pounds per head per day is considered as much as should be fed.

Lamb feeders have found silage a very satisfactory feed, and the amount fed ranges from 1 to 3 pounds per day. Where lambs are on full feed of grain, such as corn, and are receiving a fair allowance of hay, they will, as a rule, only consume from 1 to 2 pounds per head per day.

In feeding breeding ewes before lambing a daily allowance of from 2 to 3 pounds should be considered a maximum quantity. After lambing the amount can be slightly increased.

In feeding silage or any other succulent feeds it must be borne in mind that the value of such feeds to a large extent is to act as an appetizer and to keep the digestive system in good condition. Under ordinary conditions where silage is fed it should not constitute more than one-half of the entire ration, and it should be fed with other feeds that will properly balance the ration for the purpose intended.

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The Making and Feeding of Silage

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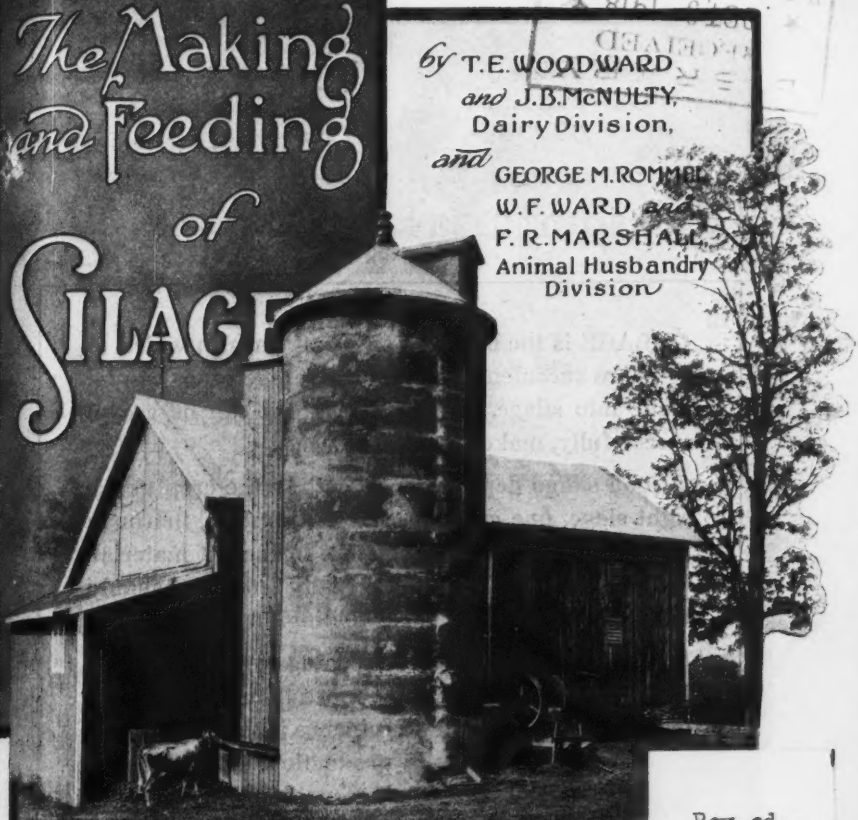

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SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all live stock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

THE MAKING AND FEEDING OF SILAGE.

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SILAGE, ITS PREPARATION AND FEEDING VALUE.

By T. E. Woodward and J. B. McNulty,

of the Dairy Division.

SILAGE is any fodder or grass that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition. Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter, or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Live stock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, healthy appearance than those fed exclusively on a dry ration.

CROPS SUITABLE FOR SILAGE.

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, of which legumes are examples, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as amber cane and orange cane (the saccharine sorghums), have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

CORN.

Corn is the common silage crop wherever it can be grown successfully. Silage made from it contains a high percentage of digestible nutrients, has a good flavor, is very palatable, and will keep in good condition for years. When it is properly siloed the losses of digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost 15.6 per cent of the dry matter, against 23.8 per cent when cut for fodder and cured in the field.[1] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since live stock need dry roughage, it is usually most satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT.

Since there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutriment than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

[1] A Book on Silage, F. W. Woll, 1900.

TABLE 1.—*Yield per acre of digestible matter in corn.*

Constituent.	Yield per acre.		
	Ears.	Stover.	Total crop.
	Pounds.	*Pounds.*	*Pounds.*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

METHODS OF PLANTING.

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 or 8 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recom-

FIG. 1.—A fine crop of corn for silage.

mended for weedy land. If serious trouble with weeds is expected the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain so high a percentage of digestible nutrients as in thin planting. At the Dairy Division farm, Beltsville, Md., it was found that corn planted at the rate of 4 stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of 2 stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on thin, poor soil.

YIELD.

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed.

The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST.

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Most of the ears should be firm to the touch, for if spongy the grain is still in the dough stage and not ready for the silo.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant.*

Yield per acre.	Stage of growth.				
	Tasseled, July 30.	Silked, Aug. 9.	Milk, Aug. 21.	Glazed, Sept. 7.	Ripe, Sept. 23.
Total yield	*Pounds.* 18,045	*Pounds.* 25,745	*Pounds.* 32,600	*Pounds.* 32,295	*Pounds.* 28,460
Water	16,426	22,666	27,957	25,093	20,542
Dry matter	1,619	3,078	4,643	7,202	7,918
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN.

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix the corn with some which is more mature. Silage from immature corn will be sourer than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Corn should be cut as soon as possible after it is frosted in order to prevent excessive drying out. When this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack and keep properly.

CORNSTALKS.

Often there is a delay in filling the silo, and it is necessary to cut and shock the corn. On farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out.

Dry cornstalks may be siloed successfully, but it is absolutely necessary that a sufficient quantity of water be added to wet them enough so that they will pack well in the silo. Water may be added by allowing a stream from a barrel or hose to flow into the blower while filling. In addition it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Silage made in this way is not so good as that put up when the corn is at the proper stage, since dry fodder standing in the field loses much of its feeding value.

SORGHUMS.

Saccharine sorghums, such as amber cane and orange cane, and nonsaccharine sorghums, such as kafir, feterita, and milo, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard. If harvested earlier, a silage with a high-acid content is produced. Experiments in Kansas[1] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

FIG. 2.—Shock corn, if properly handled, will make fair silage.

LEGUMES.

The legumes include the clovers, sweet clover, alfalfa, cowpeas, soy beans, velvet beans, and the vetches. All such forage crops, if properly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums.

[1] Circular 28, Kansas Agricultural Experiment Station.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage. When the corn or sorghum is 30 per cent or more of the total, a better-smelling and more palatable silage is produced than in the case of legumes alone. If this plan is used, both the legume and the corn must be ready for the silo at the same time.

It has been reported [1] that when ordinary blackstrap molasses was added to alfalfa silage at the rate of 1 part to 20 by weight there was a very marked improvement in the flavor, palatability, and keeping qualities of the silage.

Most legumes should be cut for silage at the same time as for hay. Clover should be cut when in full bloom or when some of the blossoms have turned brown. Cowpeas and soy beans may be used separately for silage, but the common practice is to grow them with corn or with one of the sorghums, or if grown in separate fields to mix them at the time of filling the silo. Such combinations raise the protein content of the corn or sorghum silage without greatly lowering its palatability, and the planting of either cowpeas or soy beans with corn does not lower the yield of corn. Soy beans are better suited for such use in northern sections than cowpeas.

SMALL GRAINS.

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo.

The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

[1] O. E. Reed in Hoard's Dairyman, Mar. 16, 1917.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage is especially liable to affect the flavor of milk.

FIELD PEAS AND OATS.

Peas and oats planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut this crop for silage is when the oats begin to pass from the milk into the dough stage, and when the pea pods have fair-sized peas in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats are siloed together.

MILLET.

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES.

Pea vines from canning factories are used extensively for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS.

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, which damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over

the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to make the silo as nearly air-tight as possible. Other coarse roughages, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

RAPE.

If harvested when nearly mature but still succulent, rape makes a silage of fair quality. It can be put in the silo with mature corn or sorghum, legumes, or straw, and thus produce a good grade of silage. A mixture of rape and alfalfa, clover, or sweet clover makes the best silage, being somewhat better than legumes alone, as the rape contains sugars which are lacking in legumes.

CANE TOPS AND CANE BAGASSE.

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

MISCELLANEOUS CROPS.

Beet pulp, apple pomace, Russian thistles, sunflowers, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO.

Corn or sorghums for the silo may be cut by hand with the sled cutter or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods the cost per acre of cutting corn was found to be lowest when the sled cutter was used.[1] All things considered, however, the corn harvester is a more satisfactory method of cutting corn for the silo.

In using the corn harvester the bundles should be made rather small. While this takes more twine the extra expense is more than

[1] See Bulletin 145, Nebraska Agricultural Experiment Station.

offset by the ease of handling the bundles and in feeding them into the silage cutter. Two or four horses and one man will be required to run the harvester, which should cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will dry out to any considerable extent before it is hauled to the cutter.

HAULING TO THE CUTTER.

The corn ordinarily is hauled to the cutter with the common flat hay frames. An objection to their use is the hard work necessary

FIG. 3.—A corn harvester at work.

to lift the green corn fodder so high in loading. A low-wheeled wagon is much preferable to a high-wheeled one. A low hayrack very commonly used in some parts of the United States can easily be made. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, "Cost of Filling Silos":

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle

by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the

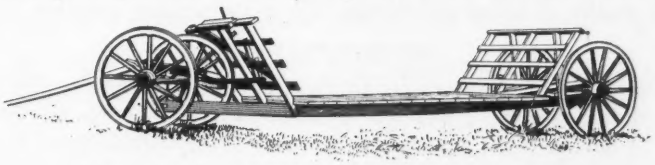

FIG. 4.—A low rack suitable for hauling corn to cutter.

loads should be smaller, thus saving the labor of high lifting in loading and facilitating the work of unloading.

CUTTING THE SILAGE.

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity of the machine to be purchased is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow

FIG. 5.—Hauling corn to the silage cutter.

and interfering with the continuous employment of the entire force of men. It is better to get a machine so large that every one will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available.

LENGTH TO CUT.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so

closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand the longer the pieces the more rapidly the corn can be run through the cutter. The bulk of the silage is now cut into pieces less than 1 inch in length. Fine cutting and good tramping are needed if it is desired to make the best quality of silage and fill the silo to its greatest capacity.

ELEVATING THE SILAGE.

Two types of elevators are in use, the old-style chain carrier and the blower (see figs. 6 and 7). The chain carrier requires less power but is harder to set up and makes more litter, especially in windy weather. Some chain carriers are so inclosed as to keep the corn

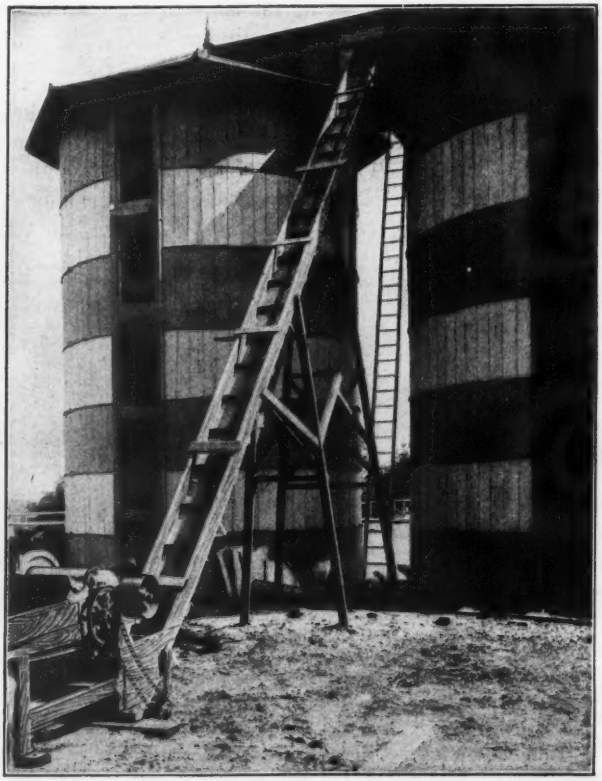

FIG. 6.—Silage cutter with chain carrier.

from blowing out. In using the blower type the blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and also lessen the danger of clogging.

POWER REQUIRED.

The power necessary to operate the cutter depends upon length of knives, sharpness of knives, type of elevator, height of the silo, the rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed slowly than if fed to full capacity. It is advisable to have sufficient power to run the cutter

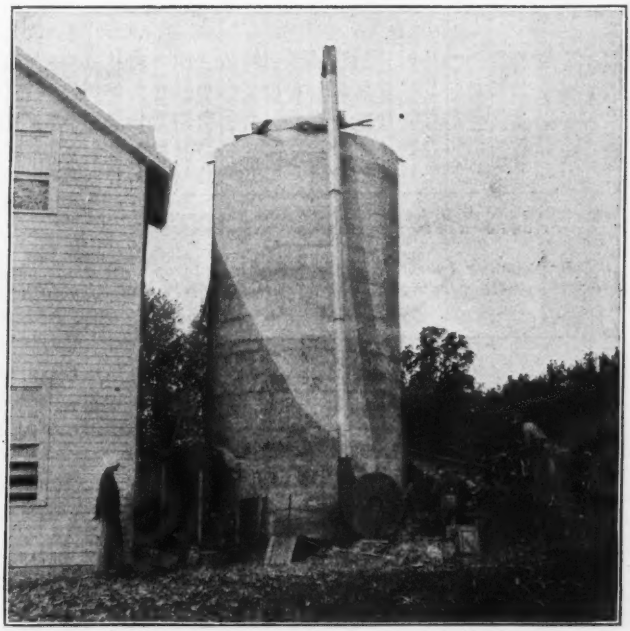

FIG. 7.—Silage cutter with blower.

at full capacity, and many prefer to have a little surplus power. Tables 3 and 4 give the power required for blowers and carriers, respectively, when gasoline engines are used. The figures given are thought to represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. If power is furnished by a steam engine the horsepower may be reduced 25 per cent, and if with an electric motor the horsepower is reduced 15 per cent. The tables have been prepared from manufacturers' statements, personal observation, and experience, and are not the result of actual experimental tests.

TABLE 3.—*Horsepower (gasoline engine) required to operate silage cutter and blower, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.0	36.6	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

TABLE 4.—*Horsepower (gasoline engine) required to operate silage cutter and chain carrier, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	2.5	2.6	2.6	2.7	2.9	2.9	2.9	3.0	3.1	3.1	3.1	3.2	3.2	3.3	2
12	4.4	4.5	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.1	5.1	5.2	5.2	3
14	6.4	6.5	6.5	6.6	6.7	6.7	6.8	6.8	7.0	7.0	7.1	7.1	7.2	7.2	5
16	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	8
18	10.5	10.7	10.9	11.7	11.1	11.3	11.4	11.6	11.7	11.8	12.0	12.1	12.2	12.4	10
20	13.0	13.1	13.4	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.4	14.6	14.7	14.9	12

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar

to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and being loosely put together, it can be swung so as to place the material anywhere in the silo (see fig. 8). With this contrivance it is not necessary to handle the material with a pitchfork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some foreign object which might pass up the blower pipe. As the silage rises in the silo the distributer pipe, which is put together in sections, can be readily shortened as required.

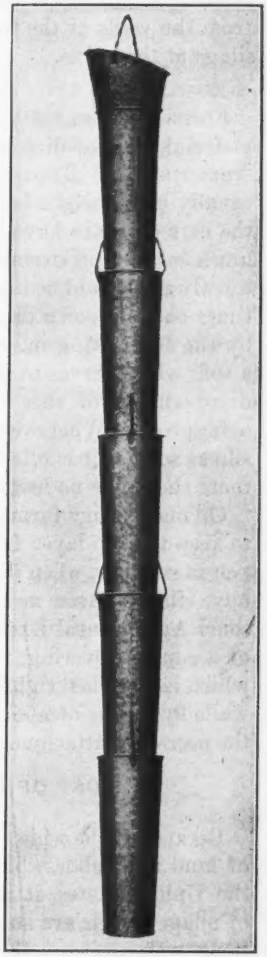

FIG. 8. — Jointed-pipe silage distributer.

A canvas distributer consisting of a tube of canvas fitted over rings can be made with little trouble and at lower cost than the pipe distributer. A distributer of that kind can be rolled up and usually gives good service.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER.

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will "firefang" or deteriorate through the growth of mold. Water enough should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be sprayed, by means of a hose and spray nozzle, directly on the silage in the silo as it is filled, or, preferably, it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

COVERING THE SILAGE.

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wet down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to shut off the air from the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled; if this is done, no covering is necessary and there should be no loss on account of spoiling.

On many dairy farms, however, the silage is not fed rapidly enough to keep the top layer from spoiling, which is especially liable to happen in summer, when the cows are on pasture and consuming little, if any, silage. As a means of preventing loss of that kind the Missouri Agricultural Experiment Station uses and recommends the use of a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls by means of a circular iron frame. By means of a pulley and the necessary attachments the canvas can be readily raised or lowered.

COST OF GROWING AND SILOING CORN.

Because of the wide variations in the yields per acre and in the cost of land and labor which are found in the corn-growing sections of the United States, it is not possible to give any figures on the cost of silage which are suitable for general application. Even if these items were uniform the yearly fluctuations in the cost of twine and fuel (gasoline, kerosene, coal, or wood) and other incidentals are such as to make it impossible to forecast the exact cost of silage in any particular instance. If, however, the various items of expense on one farm are enumerated it should be possible to determine approximately the cost of silage on other farms even though some of the conditions vary widely.

Tables 5 and 6 were compiled from data kept at the Dairy Division Experiment Farm, Beltsville, Md., where detailed records are kept on the cost of all farm operations. They are not given as representative of the exact cost of silage in other sections or even on other farms in the locality. The data apply to the complete cost of growing and siloing 65.76 acres of corn, yielding by actual weight at time of siloing 670.46 tons of silage, or an average of 10.19 tons an acre. Of the 65.76 acres, 29.3 were grown in 1915 and cut with a corn harvester. The corn on the remaining 36.46 acres, grown in 1916, was so badly lodged that it was necessary to cut it by hand. A 15–30 horsepower kerosene tractor was used to run the cutter, and was also used to plow a part of the land preparatory to planting the corn.

Land was arbitrarily valued at $100 an acre. All other items included in the tables are taken directly from the farm records. Board and room were not furnished to employees. The only known factors not considered were taxes, insurance, and the manager's time.

TABLE 5.—*Cost of growing 65.76 acres of corn for silage.*

Man hours, 2,377.4, at 18.39 cents	$437.32
Mule hours, 2,385.7, at 8.4 cents	200.38
Interest on tractor, 65.8 hours, at 20 cents	13.16
Depreciation on tractor, 65.8 hours, at $1	65.80
Supplies for tractor	25.83
Interest on land, $100 an acre, at 5 per cent	328.81
Commercial fertilizer and limestone, 91.79 tons	688.68
Barnyard manure, 280.03 tons, at $3 (one-half value first year)	420.05
Seed corn, 13.15 bushels, at $2.444	32.16
	2,212.19
Cost per acre	33.64
Cost per ton	3.30

TABLE 6.—*Cost of harvesting and siloing 65.76 acres of corn.*

Man hours, 2,653.5, at 19.34 cents an hour	$513.32
Mule hours, 1,249, at 8.4 cents an hour	104.90
Binder twine, 145.3 pounds, at 11¾ cents a pound	17.07
Tractor supplies, gasoline, and oil	70.06
Interest on tractor, 202 hours, at 20 cents	40.40
Depreciation on tractor, 202 hours, at 50 cents	101.00
Interest on corn harvester, 54.6 hours, at 4.2 cents	2.29
Depreciation on corn harvester, 54.6 hours, at 20.8 cents	11.36
Interest on cutter, 202 hours, at 8 cents	16.16
Depreciation on cutter, 202 hours, at 40 cents	80.80
Interest on 3 wagons, 3 racks, 3 sets double harness	1.13
Depreciation on 3 wagons, 3 racks, 3 sets double harness	4.66
	963.15
Cost per acre	14.65
Cost per ton	1.44

Investigations of 21 farms in the State of New York, reported in Bulletin 377 of the Cornell Agricultural Experiment Station, showed that the interest and depreciation charges on silos amounted to 24 cents a ton annually, which, added to $1.44, makes a cost of $1.68 for harvesting, siloing, and storing. This, added to the $3.30 for growing, gives a total cost of $4.98 a ton for silage when stored in the silo.

The use of both barnyard manure and commercial fertilizer for growing a crop of corn may be regarded as an exception to the general practice among farmers. As shown in Table 5, $688.68 was expended for fertilizer, and the cost of applying it was $107.62. While the latter expense is not mentioned as a separate item in Table 5, it is included in the charges for man and mule labor. Accordingly, the total cost of the fertilizer was $796.30. Had it been possible to obtain the same yields per acre and to maintain the fertility of the soil without the commercial fertilizer, the cost of the silage would have been reduced to $3.79 a ton.

Some varieties of corn, of which the Eureka is an example, have a high percentage of stalks and leaves and usually yield more per acre, and in consequence lower the cost of silage per ton. As a rule, however, such varieties produce a poorer quality of silage. Then again the tons per acre vary with the stage of maturity. It is evident, therefore, that any figures on either the cost or the feeding value of silage should take into account the kind of corn grown and its condition at the time of harvesting.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in Table 7 show the average quantity of digestible nutrients in 100 pounds of silage and other succulent feeds.

TABLE 7.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds.*

[From "Feeds and Feeding," by Henry and Morrison.]

Crop.	Total dry matter.	Digestible dry matter.			True protein.	Net energy value.
		Crude protein.	Carbohydrates.	Fat.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Therms.*
Green corn fodder	21.9	1.0	12.8	0.4	0.8	14.06
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green sorghum fodder	24.9	.7	14.1	.6	.4	15.37
Sorghum silage	22.8	.6	11.6	.5	.....	.....
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	27.8	1.3	9.5	.5	.8	7.26
Uncured soy bean	23.6	3.2	10.2	.5	2.4	12.53
Soy-bean silage	27.1	2.6	11.0	.7	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	22.0	1.8	10.1	.6	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6	.....	.....
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	10.0	.8	6.5	.3	.5	9.32
Prickly pear	16.5	.4	8.9	.2	.....	.....

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the corn belt refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

By T. E. WOODWARD and J. B. MCNULTY, *of the Dairy Division.*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous upon farms devoted to dairying than upon farms of any other kind. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. A ration, for instance, of silage and alfalfa hay alone is satisfactory, however, only for cows which are dry or give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage,

as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED.

The quantity of silage to feed a cow depends upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller dairy cows eat from 25 to 30 pounds a day, the larger ones 45 or more, and the medium-sized ones quantities varying between.

RATIONS.

In general dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day—or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in the proportion of about 2.5 to 3.5 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 4 to 4½ pounds of milk produced in addition to roughage will prove to be about right. For Jerseys 1 pound for each 3 to 3½ pounds of milk will come nearer meeting the requirements. The grain for other breeds varies between these two according to the quality of milk produced. A good rule is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of legume hay little grain is needed for cows of ordinary production.

TIME TO FEED.

The time to feed silage is directly after milking. If this is impossible, it may be fed several hours before milking. In such cases there is a chance that the silage odor may taint the milk. On the other hand, if feeding is done after milking the odors from the silage will have disappeared before the next milking hour. Silage is usually fed twice, although sometimes three times a day.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before using, after which it should be fed immediately; that is, before decomposition sets in. No harm will result from feeding silage handled in this manner, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from

mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume more than one-half as much as mature stock; that is, 20 or more pounds a day if they are well grown. When supplemented with some good leguminous hay, little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this quantity silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Cows when dry consume almost as much roughage as when they are milked. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 45 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidely more convenient to use than soiling crops. The quantities to feed depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES.

By GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been fed generally to horses, partly because of a certain degree of danger in its use, but still more, perhaps, on account of prejudice. In many cases horses have been killed by eating moldy

silage, and the careless person who fed it at once blamed the silage rather than his own carelessness and the mold, which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions varieties of mold which are deadly poisons to both horses and mules are found on silage. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warmer, he can soon detect the presence of mold. When mold appears he should immediately stop feeding the silage to horses or mules.

It is also unsafe to feed horses frozen silage because of the danger of colic. It is practically impossible to avoid frozen silage in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be carefully tramped and packed while filling. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is liable to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which may be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it, and the daily consumption is so large as to preclude the formation of mold on the surface.

To cheapen the ration of brood mares in winter no feed is of more value than good corn silage. If the grain goes into the silo with the stover no additional grain is needed for brood mares, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds of silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to

reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Mares fed in this manner will be in splendid condition for foaling, and so far as the writer's experience goes the foals will be fully as vigorous, with just as much size and bone, as if the mares were fed the conventional grain and hay ration.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases in which stallions receive rations of silage, but has had no experience in feeding them in this manner. There seems to be no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should be useful also for young horses, especially drafters, but here again the writer can not quote his own experience, and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn properly stored in the silo. When it is properly stored and is not allowed to mold, no feed exceeds it as a cheap winter ration. It is most valuable for horses, such as brood mares and work horses, and mules, which are not at heavy work, during the slack season. With plenty of grain on the cornstalk horses will keep in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

By W. F. Ward, *Formerly Animal Husbandman in Beef Cattle Investigations, Animal Husbandry Division.*

No roughage is of more importance to the producer of beef cattle than silage. The value of silage to the beef producer varies considerably and is dependent upon a large number of factors. When rough fodders and grain are scarce or high-priced, or if the grain can not be sold readily, silage will have a greater value than if the opposite conditions exist. It is a great saver of grain when fed to either stock cattle or fattening cattle. It will lessen the grain feeding by one-fourth more than the quantity of grain in the silage. The value also depends somewhat upon the kind of cattle to which it is fed. Where there is an abundance of rough fodders which can not be marketed, silage would prove to be more valuable if used for the calves and pregnant cows and the coarse fodders used for the other stock.

SILAGE FOR THE BREEDING HERD.

For wintering the entire breeding herd there is no better roughage than silage. All the animals will relish a ration of which it is a

part, and it will create an appetite for other feeds. Cows that are fed all the silage they will consume together with clover hay will go through the winter in fine shape and even make small gains. If the quantity of silage is limited, a more economical method of wintering them is to reduce the silage to half ration, letting them have the run of a straw stack and feeding about 2 pounds of cottonseed meal or oil meal a day. Some dry, coarse fodder or straw always should be kept before animals getting silage, as it reduces the quantity of silage consumed and prevents the feed from being too laxative. Succulent feed causes the breeding cows to give a good flow of milk even though the calf is born in midwinter, and the result is a thrifty calf. If the silage is free from mold or rotten spots there will be no danger in feeding it to breeding cows.

Silage is especially beneficial to calves which have just been weaned. They take to this ration more quickly than to dry feed, and there is usually little loss in weight from the weaning. The silage should be supplemented with some good leguminous hay, as alfalfa, cowpea, or clover, and the calves should be given a small quantity of grain. A mixture of one-half corn chop and one-half cottonseed meal is excellent.

SILAGE FOR STOCKERS.

Each farmer should plan the rations for his cattle according to the quantities of the various feeds he has on hand. Stockers can be wintered on silage and some good hay, fodder, or straw, but this plan may not always be the most profitable. When hay is high priced and grain is reasonably cheap, or plenty of silage is available, it may be more economical to omit the hay altogether. A ration of corn silage alone often has been profitable for thin cattle. Stockers which have been fed liberally all winter and made to put on good gains usually do not make so large daily gains when put on grass as do steers which have not been quite so well fed. The time cattle are to be finished for market and the degree of fatness to be attained should govern to a large extent the method to be followed during the winter. When beeves are expected to sell at high prices in the early summer and the steers are to be finished for market at that time, a heavy roughage ration with a little grain should be fed during the winter months.

SILAGE FOR FATTENING ANIMALS.

Silage stands first in rank of all the roughages for finishing cattle. Formerly, during the era of cheap corn and other concentrates, little attention was given to the roughage, as it was usually considered merely a "filler" and of very little economic value in feeding. No especial care was taken in selecting any particular kind,

nor was its quality seriously considered. As the prices of the concentrated feedstuffs advanced the feeder looked about for methods of cheapening the cost of producing beef, and soon found that it could be accomplished by using judgment in selecting his roughage with respect to the grain fed. This has continued until at the present time the roughage receives as much attention as the concentrated feed and has been made to take the place of a large amount of the latter. The feeding of silage came into general use with the advent of expensive grain and is becoming more popular each year. In view of the present prices of feedstuffs hardly a ration is used for feeding cattle which can not be cheapened by the use of this succulent feed. By combining it with other feeds the efficiency of the ration is increased to such extent that the daily gains are invariably greater and the cost of producing a pound of gain is lessened. The heaviest daily gains are usually made during the first stage of the feeding period, and silage can then be used to advantage in larger quantities with a small amount of grain, but as the feeding progresses the amount of silage should be lessened and that of the grain increased. In some places the prices of hay and stover are so high that the greater the proportion of silage used in the ration the more profitable is the feeding.

Conditions in general are such that any given ration will not suit a large number of farmers, nor will it be so profitable for some as it will for others; so each farmer must determine for himself just what combination of feeds will be most profitable for his use. However, to give a general idea of some of the rations adapted to different localities, and which may prove satisfactory for a 1,000-pound steer, some examples are given below:

RATIONS.

FOR THE CORN BELT.

Ration 1.

	Pounds.
Corn silage	25
Corn stover	6
Cottonseed meal or oil meal	3
Shelled corn	14

Ration 2.

Corn silage	25
Clover hay	7
Shelled corn	15

FOR THE EASTERN STATES WHERE HAY IS VERY HIGH AND CORN IS RELATIVELY HIGH.

	Pounds.
Corn silage	30
Corn stover	6
Cottonseed meal or oil meal	4
Shelled corn	10

FOR THE SOUTH, WHERE COTTONSEED MEAL IS OF MODERATE PRICE AND COWPEA HAY IS RAISED ON THE FARM.

Ration 1.

	Pounds.
Corn silage	35
Cowpea hay	8
Cottonseed meal or oil meal	7

Ration 2.

Corn silage	30
Cottonseed hulls	12
Cottonseed meal	7

FOR THOSE SECTIONS OF THE WEST WHERE CORN CAN NOT BE RAISED.

Ration 1.

	Pounds.
Kafir-corn silage	30
Prairie hay	3
Cottonseed meal	3
Kafir-corn meal	10

Ration 2.

Kafir-corn silage	25
Alfalfa	7
Kafir corn	15

It should be understood that the rations mentioned are not necessarily to be fed in the exact quantities given, but should be modified to suit local conditions and the actual conditions on each farm, also the feed prices. They are given to show approximately the average quantities and character of feed that would be consumed daily by a 1,000-pound steer during the feeding period. An example of an instance when it is advisable to make a change in these rations is at the present time (1918), when the high price of corn prohibits a profitable use of it in large quantities in rations for fattening cattle for market.

SILAGE FOR SHEEP.

By F. R. MARSHALL, *in charge of Sheep and Goat Investigations, Animal Husbandry Division.*

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. These beliefs are unfounded, and it has been proved by different experiment stations in tests with both breeding and feeder lambs that silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK.

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be retained in the ration.

Silage shows the best results when fed with a good legume hay. A satisfactory ration for a breeding ewe would consist of the following:

	Pounds.
Corn silage	3 to 4
Clover or alfalfa hay	¾ to 1

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary.

SILAGE FOR LAMBS.

In fattening lambs corn silage not only saves hay and grain, but reduces the cost of production and increases the selling value per head when compared with other rations fed.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana Experiment Station is as follows:

	Pounds.
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.12

In wintering ewe lambs silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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The MAKING AND FEEDING OF SILAGE

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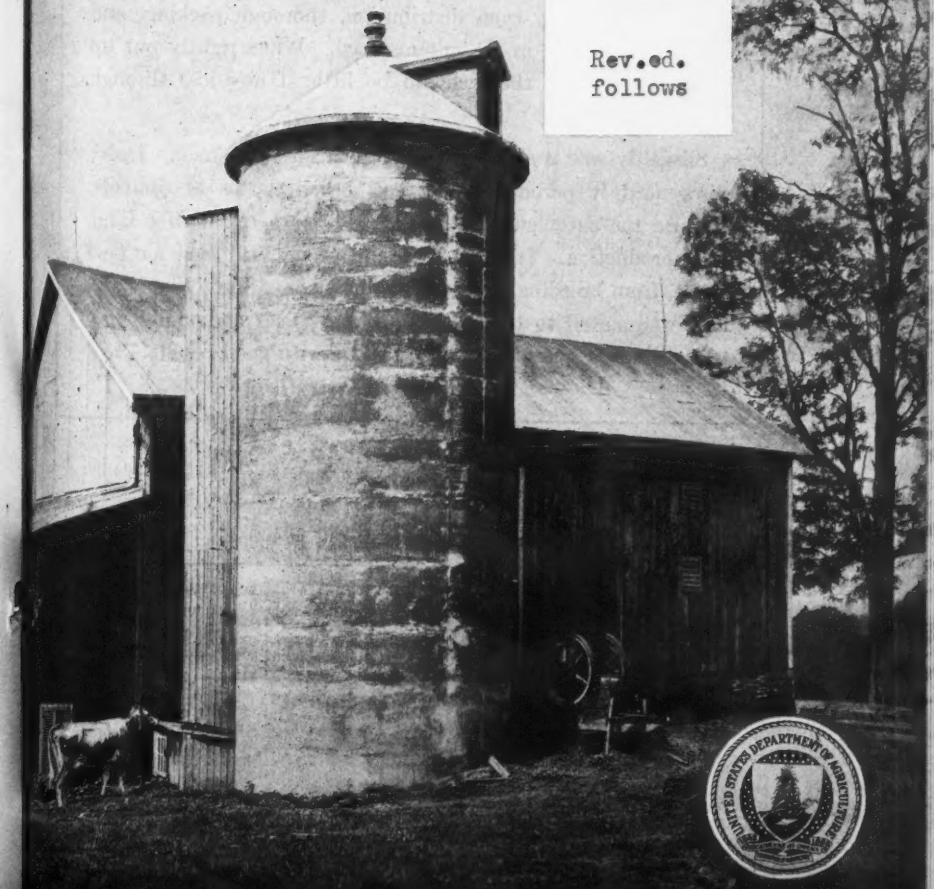

SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all live stock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief

Washington, D. C.

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THE MAKING AND FEEDING OF SILAGE.

T. E. Woodward and J. B. McNulty, *Dairy Division*, and George M. Rommel, E. W. Sheets, and F. R. Marshall, *Animal Husbandry Division*.

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SILAGE, ITS PREPARATION AND FEEDING VALUE.

T. E. Woodward and J. B. McNulty, *of the Dairy Division*.

SILAGE is any fodder or grass that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition. Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter, or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Live stock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, healthy appearance than those fed exclusively on dry rations.

CROPS SUITABLE FOR SILAGE.

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, of which legumes are examples, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as the saccharine sorghums, have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

CORN.

Corn is the common silage crop wherever it can be grown successfully. Silage made from it contains a high percentage of digestible nutrients, has a good flavor, is very palatable, and will keep in good condition for years. When it is properly siloed the losses of digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost 15.6 per cent of the dry matter, against 23.8 per cent when cut for fodder and cured in the field.[1] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since live stock need dry roughage, it is usually most satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT.

Since there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutriment than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

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[1] A Book on Silage, F. W. Woll, 1900.

TABLE 1.— *Yield per acre of digestible matter in corn.*

Constituents.	Yield per acre.		
	Ears.	Stover.	Total crop.
	Pounds.	*Pounds.*	*Pounds.*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

FIG. 1.—A fine crop of corn for silage.

METHODS OF PLANTING.

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 or 8 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recommended for weedy land. If serious trouble with weeds is expected

the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain so high a percentage of digestible nutrients as in thin planting. At the Dairy Division farm, Beltsville, Md., it was found that corn planted at the rate of 4 stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of 2 stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on poor soil.

YIELD.

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed.

The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST.

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant.*

Yield per acre.	Stage of growth.				
	Tasseled, July 30.	Silked, Aug. 9.	Milk, Aug. 21.	Glazed, Sept. 7.	Ripe, Sept. 23.
Total yield	*Pounds.* 18,045.00	*Pounds.* 25,745.00	*Pounds.* 32,600.00	*Pounds.* 32,295.00	*Pounds.* 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	20,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN.

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix the corn with some which is more mature. Silage from immature corn will be sourer than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack and keep properly.

DRY CORN FODDER.

Sometimes there is a delay in filling the silo, and it is necessary to cut and shock the corn. On farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out.

Dry corn fodder may be siloed successfully, but it is absolutely necessary that a sufficient quantity of water be added to wet it enough so that it will pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower while filling. In addition it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[1] Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

[1] Circular No. 71, Missouri Agricultural Experiment Station.

SORGHUMS.

Saccharine sorghums, such as amber cane and orange cane, and nonsaccharine sorghums, such as kafir, feterita, milo, and Sudan grass, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard.

FIG. 2.—Shock corn, if properly handled, will make fair silage.

If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas [1] and California [2] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

LEGUMES.

The legumes include the clovers, sweet clover, alfalfa, cowpea, soy beans, velvet beans, and the vetches. All such forage crops, if prop-

[1] Circular 28, Kansas Agricultural Experiment Station.
[2] Bulletin 282, California Agricultural Experiment Station.

erly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums. It has been reported [1] that when ordinary blackstrap molasses was added to alfalfa silage at the rate of 1 part to 20 by weight there was a very marked improvement in the flavor, palatability, and keeping qualities of the silage. Most legumes should be cut for silage at the same time as for hay.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage.

Cowpeas and soy beans may be siloed separately, but generally they are used in combination with corn or sorghum. They are grown either in separate fields or with the corn. Cowpeas when grown with corn climb the stalks and make harvesting difficult. Soy beans being self-supporting can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soy beans make a more satisfactory crop to grow with the corn. Some authorities assert that soy beans grown with corn do not lower the yield of corn, but an experiment on the Dairy Division farm at Beltsville, Md., indicates otherwise. Probably the most desirable plan is to grow the legumes in separate fields, and mix them with the corn at silo-filling time.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS.

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo.

The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the

[1] O. E. Reed in Hoard's Dairyman, Mar. 16, 1917.

early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage is especially liable to affect the flavor of milk.

FIELD PEAS AND OATS.

Peas and oats planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut this crop for silage is when the oats begin to pass from the milk into the dough stage, and when the pea pods have fair-sized peas in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats are siloed together.

MILLET.

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES.

Pea vines from canning factories are used extensively for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS.

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it

damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to make the silo as nearly air-tight as possible. Other coarse roughages, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

RAPE.

If harvested when nearly mature but still succulent, rape makes a silage of fair quality. It can be put in the silo with mature corn or sorghum, legumes, or straw, and thus produce a good grade of silage. A mixture of rape and alfalfa, clover, or sweet clover makes the best silage, being somewhat better than legumes alone, as the rape contains sugars which are lacking in legumes.

CANE TOPS AND CANE BAGASSE.

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS.

Sunflowers are coming into more general use on the irrigated lands of the West and Northwest, where the weather is too cool and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn. As high as 29.75 tons to the acre have been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

MISCELLANEOUS CROPS.

Beet pulp, apple pomace, Russian thistles, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO.

Corn or sorghums for the silo may be cut by hand, with the sled cutter, or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods, the cost per acre of cutting corn was found to be

FIG. 3.—A corn harvester at work.

lowest when the sled cutter was used.[1] All things considered, however, the corn harvester is a more satisfactory method of cutting corn for the silo.

In using the corn harvester the bundles should be made rather small. While this takes more twine the extra expense is more than offset by the ease of handling the bundles and in feeding them into the silage cutter. Two to four horses and one man will be required to run the harvester, which should cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will lose any considerable moisture before it is hauled to the cutter.

HAULING TO THE CUTTER.

The corn ordinarily is hauled to the cutter with the common flat hay frames. An objection to their use is the hard work necessary

[1] See Bulletin 145, Nebraska Agricultural Experiment Station.

to lift the green corn fodder so high in loading. A low-wheeled wagon is much preferable to a high-wheeled one. A low hayrack very commonly used in some parts of the United States can easily be made. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, "Cost of Filling Silos":

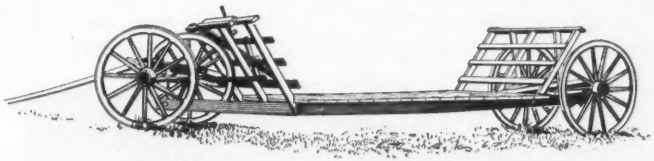

FIG. 4.—A low rack suitable for hauling corn to cutter.

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

FIG. 5.—Hauling corn to the silage cutter.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading, and facilitating the work of unloading.

CUTTING THE SILAGE.

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity of the machine to be purchased is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine so large that every one will

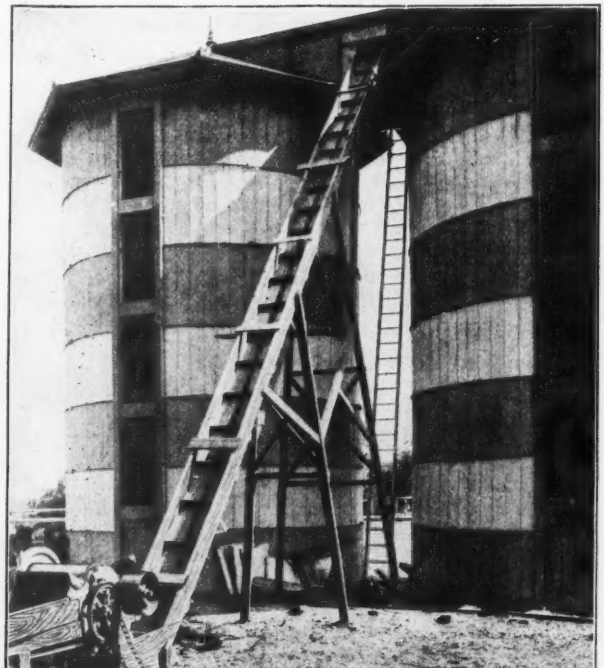

FIG. 6.—Silage cutter with chain carrier.

be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available.

LENGTH TO CUT.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so

closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand the longer the pieces the more rapidly the corn can be run through the cutter. The bulk of the silage is now cut into pieces less than 1 inch in length. Fine cutting and good tramping are needed if it is desired to make the best quality of silage and fill the silo to its greatest capacity.

ELEVATING THE SILAGE.

Two types of elevators are in use, the old-style chain carrier and the blower (see figs. 6 and 7). The chain carrier requires less power but is harder to set up and makes more litter, especially in windy

FIG. 7.—Silage cutter with blower.

weather. Some chain carriers are so inclosed as to keep the corn from blowing out. In using the blower type the blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

POWER REQUIRED.

The power necessary to operate the cutter depends upon length of knives, sharpness of knives, type of elevator, height of the silo, the rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed slowly than if fed to full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. Tables 3 and 4 give the power required for blowers and carriers,

respectively, when gas engines are used. The figures given are thought to represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy well-eared corn. If power is furnished by a steam engine the horsepower may be reduced 25 per cent, and if by an electric motor the horsepower is reduced 15 per cent. The tables have been prepared from manufacturers' statements, personal observations, and experience, and are not the result of actual experimental tests.

TABLE 3.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

TABLE 4.—*Horsepower (gas engine) required to operate silage cutter and chain carrier, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	2.5	2.6	2.6	2.7	2.9	2.9	2.9	3.0	3.1	3.1	3.1	3.2	3.2	3.3	3
12	4.4	4.5	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.1	5.1	5.2	5.2	3
14	6.4	6.5	6.5	6.6	6.7	6.7	6.8	6.8	7.0	7.0	7.1	7.1	7.2	7.2	5
16	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	8
18	10.5	10.7	10.9	11.7	11.1	11.3	11.4	11.6	11.7	11.8	12.0	12.1	12.2	12.4	10
20	13.0	13.1	13.4	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.4	14.6	14.7	14.9	12

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping

the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being loosely put together can be swung so as to place the material anywhere in the silo (see fig. 8). With this contrivance it is not necessary to handle the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some foreign object which might pass up the blower pipe. As the silage rises in the silo the distributer pipe, which is put together in sections, can be readily shortened as required.

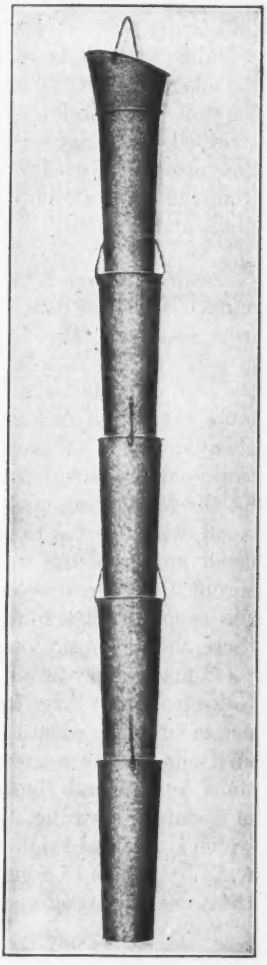

FIG. 8.—Jointed-pipe silage distributer.

A canvas distributer consisting of a tube of canvas fitted over rings can be made with little trouble and at lower cost than the pipe distributer. A distributer of that kind can be rolled up and usually gives good service.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER.

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will "firefang" or deteriorate through the growth of mold. Water enough should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied, by means of a hose and spray nozzle, directly on the silage in the silo as it is filled, or, preferably, it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

COVERING THE SILAGE.

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to shut off the air from the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled; if this is done, no covering is necessary and there should be no loss on account of spoiling.

On many dairy farms, however, the silage is not fed rapidly enough to keep the top layer from spoiling, which is especially liable to happen in summer, when the cows are on pasture and consuming little, if any, silage. As a means of preventing loss of that kind the Missouri Agricultural Experiment Station uses and recommends the use of a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls by means of a circular iron frame. By means of a pulley and the necessary attachments the canvas can be readily raised or lowered.

COST OF GROWING AND SILOING CORN.

Because of the wide variations in the yields per acre and in the cost of land and labor which are found in the corn-growing sections of the United States, it is not possible to give any figures on the cost of silage which are suitable for general application. Even if these items were uniform the yearly fluctuations in the cost of twine and fuel (gasoline, kerosene, coal, or wood) and other incidentals are such as to make it impossible to forecast the exact cost of silage in

any particular instance. If, however, the various items of expense on one farm are enumerated it should be possible to determine approximately the cost of silage on other farms even though some of the conditions vary widely.

Tables 5 and 6 were compiled from data kept at the Dairy Division Farm, Beltsville, Md., where detailed records are kept on the cost of all farm operations. They are not given as representative of the exact cost of silage in other sections or even on other farms in the locality. The data apply to the complete cost of growing and siloing 65.76 acres of corn, yielding by actual weight at time of siloing 670.46 tons of silage, or an average of 10.19 tons an acre. Of the 65.76 acres, 29.3 were grown in 1915 and cut with a corn harvester. The corn on the remaining 36.46 acres, grown in 1916, was so badly lodged that it was necessary to cut it by hand. A 15–30 horsepower kerosene tractor was used to run the cutter, and was also used to plow a part of the land preparatory to planting the corn.

Land was arbitrarily valued at $100 an acre. All other items included in the tables are taken directly from the farm records. Board and room were not furnished to employees. The only known factors not considered were taxes, insurance, and the manager's time.

TABLE 5.—*Cost of growing 65.76 acres of corn for silage.*

Man hours, 2,377.4, at 18.39 cents	$437.32
Mule hours, 2,385.7, at 8.4 cents	200.38
Interest on tractor, 65.8 hours, at 20 cents	13.16
Depreciation on tractor, 65.8 hours, at $1	65.80
Supplies for tractor	25.83
Interest on land, $100 an acre, at 5 per cent	328.81
Commercial fertilizer and limestone, 91.79 tons	688.68
Barnyard manure, 280.03 tons, at $3 (one-half value first year)	420.05
Seed corn, 13.15 bushels, at $2.444	32.16
	2,212.19
Cost per acre	33.64
Cost per ton	3.30

TABLE 6.—*Cost of harvesting and siloing 65.76 acres of corn.*

Man hours, 2,653.5, at 19.34 cents an hour	$513.32
Mule hours, 1,249, at 8.4 cents an hour	104.90
Binder twine, 145.3 pounds, at 11¾ cents a pound	17.07
Tractor supplies, gasoline, and oil	70.06
Interest on tractor, 202 hours, at 20 cents	40.40
Depreciation on tractor, 202 hours, at 50 cents	101.00
Interest on corn harvester, 54.6 hours, at 4.2 cents	2.29
Depreciation on corn harvester, 54.6 hours, at 20.8 cents	11.36
Interest on cutter, 202 hours, at 8 cents	16.16
Depreciation on cutter, 202 hours, at 40 cents	80.80
Interest on 3 wagons, 3 racks, 3 sets double harness	1.13
Depreciation on 3 wagons, 3 racks, 3 sets double harness	4.66
	963.15
Cost per acre	14.65
Cost per ton	1.44

Investigations of 21 farms in the State of New York, reported in Bulletin 377 of the Cornell Agricultural Experiment Station, showed that the interest and depreciation charges on silos amounted to 24 cents a ton annually, which, added to $1.44, makes a cost of $1.68 for harvesting, siloing, and storing. This, added to the $3.30 for growing, gives a total cost of $4.98 a ton for silage when stored in the silo

The use of both barnyard manure and commercial fertilizer for growing a crop of corn may be regarded as an exception to the general practice among farmers. As shown in Table 5, $688.68 was expended for fertilizer, and the cost of applying it was $107.62. While the latter expense is not mentioned as a separate item in Table 5, it is included in the charges for man and mule labor. Accordingly, the total cost of the fertilizer was $796.30. Had it been possible to obtain the same yields per acre and to maintain the fertility of the soil without the commercial fertilizer, the cost of the silage would have been reduced to $3.79 a ton.

Some varieties of corn, of which the Eureka is an example, have a high percentage of stalks and leaves and usually yield more per acre, and in consequence lower the cost of silage per ton. As a rule, however, such varieties produce a poorer quality of silage. Then again the tons per acre vary with the stage of maturity. It is evident, therefore, that any figures on either the cost or the feeding value of silage should take into account the kind of corn grown and its condition at the time of harvesting.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in Table 7 show the average quantity of digestible nutrients in 100 pounds of silage and other succulent feeds.

TABLE 7.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds.*

[From "Feeds and Feeding," by Henry and Morrison.]

Crop.	Total dry matter.	Digestible dry matter.			True protein.	Net energy value.
		Crude protein.	Carbohydrates.	Fat.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Therms.*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.06
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder	24.9	.7	14.1	.6	.4	15.37
Sorghum silage	22.8	.6	11.6	.5		
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	27.8	1.3	9.5	.5	.8	7.26
Uncured soy bean	23.6	3.2	10.2	.5	2.4	12.53
Soy-bean silage	27.1	2.6	11.0	.7	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	22.0	1.8	10.1	.6	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6		
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	10.0	.8	6.5	.3	.5	9.32
Prickly pear	15.5	.4	8.9	.2		

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the Corn Belt refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

T. E. WOODWARD and J. B. MCNULTY, *of the Dairy Division.*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous upon farms devoted to dairying than upon farms of any other kind. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. However, a ration, of silage and legume hay without grain is satisfactory only for cows which are dry or which give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED.

The quantity of silage to feed a cow depends upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller dairy cows eat from 20 to 30 pounds a day and the larger as much as 40 or more.

RATIONS.

In general, dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day, or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in

the proportion of about 2.5 to 3.0 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 4 pounds of milk produced in addition to roughage will prove to be about right. For Jerseys 1 pound for each 2½ to 3 pounds of milk will come nearer to meeting the requirements. The grain for other breeds varies between these two according to the quality of milk produced. A good rule is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of first-class legume hay little grain is needed for cows of ordinary production. Alfalfa especially, if fed liberally, will enable the feeder to reduce the grain allowance to the minimum.

TIME TO FEED.

The time to feed silage is directly after milking. If this is impossible, it may be fed several hours before milking. In such cases there is a chance that the silage odor may taint the milk. On the other hand, if feeding is done after milking the odors from the silage will have disappeared before the next milking hour. Silage is usually fed twice, although sometimes three times a day.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before using, after which it should be fed immediately, that is, before decomposition sets in. No harm will result from feeding silage handled in this manner, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume more than one-half as much as mature stock, that is, 20 or more pounds a day if they are well grown. When supplemented with some good leguminous hay little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this quantity silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Cows when dry consume almost as much roughage as when they are at the pail. Silage may well form the principal ingredient of their

ration; in fact, with from 25 to 40 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. The quantities to feed depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES.

GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been fed generally to horses, partly because of a certain degree of danger in its use, but still more, perhaps, on account of prejudice. In many cases horses have been killed by eating moldy silage, and the careless person who fed it at once blamed the silage rather than his own carelessness and the mold, which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions varieties of mold which are deadly poisons to both horses and mules are found on silage. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warmer, he can soon detect the presence of mold. When mold appears he should immediately stop feeding the silage to horses or mules.

It is also unsafe to feed horses frozen silage because of the danger of colic. It is practically impossible to avoid frozen silage in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be carefully tramped and packed while filling. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is liable to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which may be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it and the daily consumption is so large as to preclude the formation of mold on the surface.

Good corn silage is a splendid feed for cheapening the ration for idle horses in winter. If the grain goes into the silo with the stover no additional grain is needed for them, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds of silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases in which stallions receive rations of silage, but has had no experience in feeding them in this manner. There seems to be no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should be useful also for young horses, especially drafters, but here again the writer can not quote his own experience, and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn properly stored in the silo. When it is properly stored and is not allowed to mold, no feed excels it as

a cheap winter ration. With plenty of grain on the cornstalk horses have been kept in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

E. W. SHEETS, *of the Animal Husbandry Division.*

There is no roughage which occupies a place of more importance in the economical feeding of beef cattle than silage. The increased value of all roughages as well as of grain has correspondingly increased the value of silage in its various forms for beef production. While silage is not a cheap feed it is in most cases a great saver of grain as well as other feeds whether fed to breeding stock, growing animals, or fattening cattle.

SILAGE FOR THE BREEDING HERD.

Silage should form the principal part of the winter ration for the breeding herd. Cows and calves relish it and thrive upon it. Silage in the ration creates an appetite for less palatable and cheaper roughages, especially for the dry cows, thus reducing the cost of wintering. Good legume hays as a rule should be fed to the cows suckling calves unless a protein concentrate, such as cottonseed meal or oil meal, is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain their weight.

TABLE 8.—*Suggested rations for wintering beef cows.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc)	6 to 8	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	6 to 8	.....	.....
Cereal straw (oat, wheat, rye, etc.)	2 to 4	2 to 4	8 to 10	.....
Protein concentrate (oil meal, cottonseed meal, etc.)	.....	½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughages, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be largely determined by the quality of the silage. If there is little mature corn in the silage or if the mature corn was removed before filling the silo, it is necessary to give more silage or to supplement it with other or more nutritious feeds.

Uniformly good results have been obtained when one-half the silage fed to cows has been used in the ration of the breeding bull. As in the ration for breeding cows a small amount of grain should be supplied in addition to the amount of silage used, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES.

Before they are weaned calves should be fed silage only in limited quantities.

Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little weight during the weaning period. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay. A calf will eat the coarser, cheaper roughages but as a rule will give greater returns than older cattle from the use of better feeds and dry roughages, such as clover, alfalfa, and lespedeza.

A small quantity of grain should also be given for best results, together with a very little oil meal or cottonseed meal.

The following rations will keep calves weighing from 400 to 600 pounds growing in a thrifty condition and allow considerable gain during the winter:

TABLE 9.—*Suggested rations for wintering beef calves.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	15 to 20	15 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	4 to 6	.....	.....
Cereal straw (oat, wheat, etc.)	.....	.....	4 to 6	.....
Protein concentrates (oil meal, cottonseed meal, etc.)	.....	½ to ½	½ to 1	¾ to 1½

SILAGE FOR WINTERING STOCKERS.

The ration for wintering stockers or feeders depends largely upon the feeds available. While silage is undoubtedly one of the best feeds for wintering stockers of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do breeding cows or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Many, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better

advantage than other cattle except possibly dry cows. When such silage is used it should be fed more liberally than where no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is desirable that stockers make some gain during the winter if they are to make the maximum gain for the year.

Silage can hardly be replaced economically in the ration by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price and grain comparatively cheap, it may be advisable to limit the dry roughage to a few pounds and greatly increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, oil meal, or velvet beans. The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals.

TABLE 10.—*Suggested rations for wintering yearling stockers and feeders.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4			
Nonlegume hay (grass hays, also stover)		3 to 4		
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	
Protein concentrate (cottonseed meal, oil meal, etc.)		½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are especially adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of silage fed. The dry roughages should also be increased accordingly from 3 to 5 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE.

Silage is almost indispensable in the ration for fattening cattle. The feeding of silage came into use with the advent of high-priced grain and has become more popular each year. With the price of grain as well as roughages remaining as it has been for several years there are few rations that can not be very greatly cheapened and benefited by the addition of silage in liberal amounts in some form or other, especially at the beginning of the feeding period.

Results of recent experimental work indicate that steers can be brought to a satisfactory finish on a ration which includes but little grain, except that which is fed in the silage. In such cases the silage should provide the basis of the ration, the steers being allowed as

much as they will eat, supplemented by cottonseed meal or oil meal with alfalfa or clover hay in addition. The rate of daily gain and the degree of finish attained by steers fed in this manner have been found to be only slightly below the gain and finish made by steers fed rations containing considerably more grain. It is at once evident, however, that the silage used must be of good quality and no mature ears whatever removed in order to insure the most satisfactory results. This ration probably will become extensively used in time, as it is more than likely that the bulk of the beef of the future will be eaten with less fat than formerly.

For 1,000-pound fattening animals the following average rations should be found satisfactory:

TABLE 11.—*Suggested rations for fattening cattle.*

Feeds fed.	Average daily amount of feed.[1]				
	Ration 1.	Ration 2.	Ration 3.	Ration 4.	Ration 5.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8	.....	.....	1½ to 2
Nonlegume hay (grass, hay, also stover)	.....	.....	4 to 6	6 to 8	.....
Protein concentrate,[2] cottonseed meal, oil meal, etc	2 to 3	.....	3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10	.....	.....

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found aproximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts given but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP.

F. R. MARSHALL, *in charge of Sheep and Goat Investigations, Animal Husbandry Division.*

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. These beliefs are unfounded, and it has been proved by different experiment stations in tests with both breeding and feeder lambs that silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK.

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be retained in the ration.

Silage shows the best results when fed with a good legume hay. A satisfactory ration for a breeding ewe would consist of the following:

	Pounds.
Corn silage	3 to 4
Clover or alfalfa hay	¾ to 1

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable.

SILAGE FOR LAMBS.

In fattening lambs corn silage not only saves hay and grain, but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume

about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds.
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.12

In wintering ewe lambs silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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The MAKING AND FEEDING OF SILAGE

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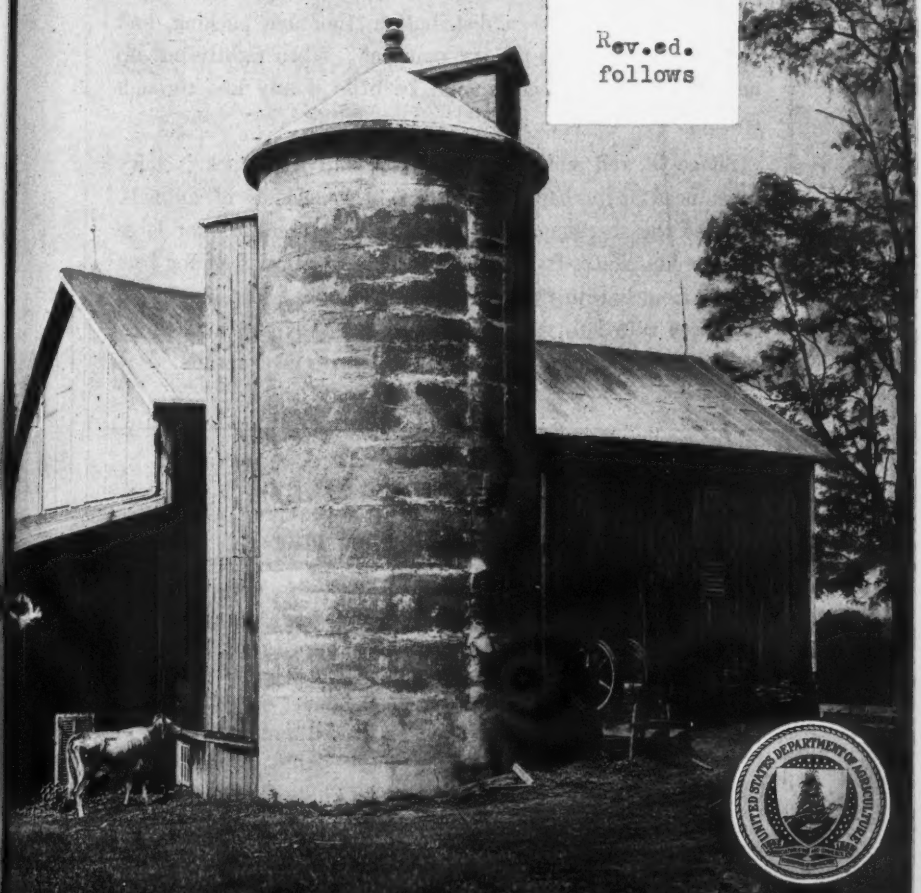

SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all live stock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

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JOHN R. MOHLER, Chief
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THE MAKING AND FEEDING OF SILAGE.

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SILAGE, ITS PREPARATION AND FEEDING VALUE.

T. E. WOODWARD and J. B. MCNULTY, *of the Dairy Division*.

SILAGE is any fodder or grass that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition. Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter, or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Live stock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, healthy appearance than those fed exclusively on dry rations.

CROPS SUITABLE FOR SILAGE.

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, of which legumes are examples, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as the saccharine sorghums, have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

CORN.

Corn is the common silage crop wherever it can be grown successfully. Silage made from it contains a high percentage of digestible nutrients, has a good flavor, is very palatable, and will keep in good condition for years. When it is properly siloed the losses of digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost 15.6 per cent of the dry matter, against 23.8 per cent when cut for fodder and cured in the field.[1] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since live stock need dry roughage, it is usually most satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT.

Since there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutriment than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

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[1] A Book on Silage, F. W. Woll ,1900.

TABLE 1.— *Yield per acre of digestible matter in corn.*

Constituents.	Yield per acre.		
	Ears.	Stover.	Total crop.
	Pounds.	*Pounds.*	*Pounds.*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

FIG. 1.—A fine crop of corn for silage.

METHODS OF PLANTING.

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 or 8 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recommended for weedy land. If serious trouble with weeds is expected

the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain so high a percentage of digestible nutrients as in thin planting. At the Dairy Division farm, Beltsville, Md., it was found that corn planted at the rate of 4 stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of 2 stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on poor soil.

YIELD.

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed.

The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST.

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant.*

Yield per acre.	Stage of growth.				
	Tasseled, July 30.	Silked, Aug. 9.	Milk, Aug. 21.	Glazed, Sept. 7.	Ripe, Sept. 23.
Total yield	*Pounds.* 18,045.00	*Pounds.* 25,745.00	*Pounds.* 32,600.00	*Pounds.* 32,295.00	*Pounds.* 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	20,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN.

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix the corn with some which is more mature. Silage from immature corn will be sourer than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack and keep properly.

DRY CORN FODDER.

Sometimes there is a delay in filling the silo, and it is necessary to cut and shock the corn. On farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out.

Dry corn fodder may be siloed successfully, but it is absolutely necessary that a sufficient quantity of water be added to wet it enough so that it will pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower while filling. In addition it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[1] Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

[1] Circular No. 71, Missouri Agricultural Experiment Station

SORGHUMS.

Saccharine sorghums, such as amber cane and orange cane, and nonsaccharine sorghums, such as kafir, feterita, milo, and Sudan grass, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard.

FIG. 2.—Shock corn, if properly handled, will make fair silage.

If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas [1] and California [2] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

LEGUMES.

The legumes include the clovers, sweet clover, alfalfa, cowpea, soy beans, velvet beans, and the vetches. All such forage crops, if prop-

[1] Circular 28, Kansas Agricultural Experiment Station.
[2] Bulletin 282, California Agricultural Experiment Station.

erly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums. It has been reported [1] that when ordinary blackstrap molasses was added to alfalfa silage at the rate of 1 part to 20 by weight there was a very marked improvement in the flavor, palatability, and keeping qualities of the silage. Most legumes should be cut for silage at the same time as for hay.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage.

Cowpeas and soy beans may be siloed separately, but generally they are used in combination with corn or sorghum. They are grown either in separate fields or with the corn. Cowpeas when grown with corn climb the stalks and make harvesting difficult. Soy beans being self-supporting can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soy beans make a more satisfactory crop to grow with the corn. Some authorities assert that soy beans grown with corn do not lower the yield of corn, but an experiment on the Dairy Division farm at Beltsville, Md., indicates otherwise. Probably the most desirable plan is to grow the legumes in separate fields, and mix them with the corn at silo-filling time.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS.

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo.

The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the

[1] O. E. Reed in Hoard's Dairyman, Mar. 16, 1917.

early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage is especially liable to affect the flavor of milk.

FIELD PEAS AND OATS.

Peas and oats planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut this crop for silage is when the oats begin to pass from the milk into the dough stage, and when the pea pods have fair-sized peas in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats are siloed together.

MILLET.

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES.

Pea vines from canning factories are used extensively for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS.

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it

damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to make the silo as nearly air-tight as possible. Other coarse roughages, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

RAPE.

If harvested when nearly mature but still succulent, rape makes a silage of fair quality. It can be put in the silo with mature corn or sorghum, legumes, or straw, and thus produce a good grade of silage. A mixture of rape and alfalfa, clover, or sweet clover makes the best silage, being somewhat better than legumes alone, as the rape contains sugars which are lacking in legumes.

CANE TOPS AND CANE BAGASSE.

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS.

Sunflowers are coming into more general use on the irrigated lands of the West and Northwest, where the weather is too cool and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn. As high as 29.75 tons to the acre have been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

MISCELLANEOUS CROPS.

Beet pulp, apple pomace, Russian thistles, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO.

Corn or sorghums for the silo may be cut by hand, with the sled cutter, or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods, the cost per acre of cutting corn was found to be

FIG. 3.—A corn harvester at work.

lowest when the sled cutter was used.[1] All things considered, however, the corn harvester is a more satisfactory method of cutting corn for the silo.

In using the corn harvester the bundles should be made rather small. While this takes more twine the extra expense is more than offset by the ease of handling the bundles and in feeding them into the silage cutter. Two to four horses and one man will be required to run the harvester, which should cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will lose any considerable moisture before it is hauled to the cutter.

HAULING TO THE CUTTER.

The corn ordinarily is hauled to the cutter with the common flat hay frames. An objection to their use is the hard work necessary

[1] See Bulletin 145, Nebraska Agricultural Experiment Station.

to lift the green corn fodder so high in loading. A low-wheeled wagon is much preferable to a high-wheeled one. A low hayrack very commonly used in some parts of the United States can easily be made. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, "Cost of Filling Silos":

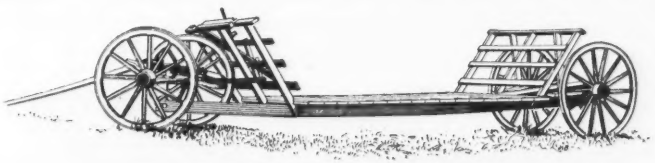

FIG. 4.—A low rack suitable for hauling corn to cutter.

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

FIG. 5.—Hauling corn to the silage cutter.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading, and facilitating the work of unloading.

CUTTING THE SILAGE.

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity of the machine to be purchased is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine so large that every one will

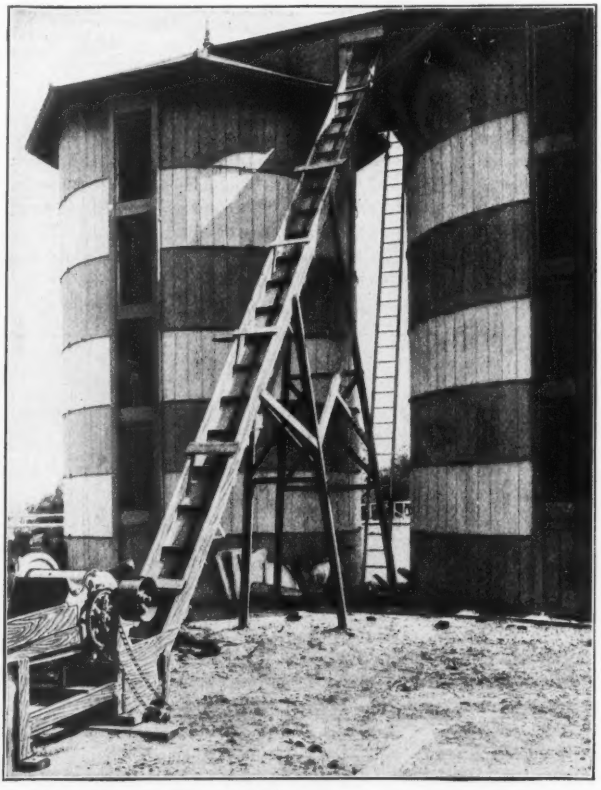

FIG. 6.—Silage cutter with chain carrier.

be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available.

LENGTH TO CUT.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so

closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand the longer the pieces the more rapidly the corn can be run through the cutter. The bulk of the silage is now cut into pieces less than 1 inch in length. Fine cutting and good tramping are needed if it is desired to make the best quality of silage and fill the silo to its greatest capacity.

ELEVATING THE SILAGE.

Two types of elevators are in use, the old-style chain carrier and the blower (see figs. 6 and 7). The chain carrier requires less power but is harder to set up and makes more litter, especially in windy

FIG. 7.—Silage cutter with blower.

weather. Some chain carriers are so inclosed as to keep the corn from blowing out. In using the blower type the blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

POWER REQUIRED.

The power necessary to operate the cutter depends upon length of knives, sharpness of knives, type of elevator, height of the silo, the rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed slowly than if fed to full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. Tables 3 and 4 give the power required for blowers and carriers,

respectively, when gas engines are used. The figures given are thought to represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy well-eared corn. If power is furnished by a steam engine the horsepower may be reduced 25 per cent, and if by an electric motor the horsepower is reduced 15 per cent. The tables have been prepared from manufacturers' statements, personal observations, and experience, and are not the result of actual experimental tests.

TABLE 3.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														*Tons per hour.*
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

TABLE 4.—*Horsepower (gas engine) required to operate silage cutter and chain carrier, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														*Tons per hour.*
10	2.5	2.6	2.6	2.7	2.9	2.9	2.9	3.0	3.1	3.1	3.1	3.2	3.2	3.3	3
12	4.4	4.5	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.1	5.1	5.2	5.2	3
14	6.4	6.5	6.5	6.6	6.7	6.7	6.8	6.8	7.0	7.0	7.1	7.1	7.2	7.2	5
16	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	8
18	10.5	10.7	10.9	11.7	11.1	11.3	11.4	11.6	11.7	11.8	12.0	12.1	12.2	12.4	10
20	13.0	13.1	13.4	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.4	14.6	14.7	14.9	12

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping

the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being loosely put together can be swung so as to place the material anywhere in the silo (see fig. 8). With this contrivance it is not necessary to handle the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some foreign object which might pass up the blower pipe. As the silage rises in the silo the distributer pipe, which is put together in sections, can be readily shortened as required.

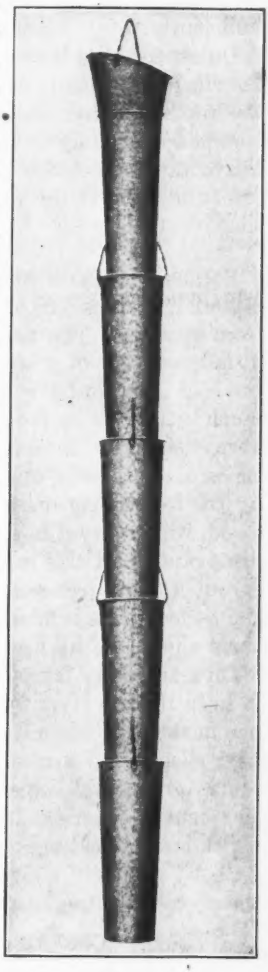

FIG. 8.—Jointed-pipe silage distributer.

A canvas distributer consisting of a tube of canvas fitted over rings can be made with little trouble and at lower cost than the pipe distributer. A distributer of that kind can be rolled up and usually gives good service.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER.

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will "firefang" or deteriorate through the growth of mold. Water enough should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied, by means of a hose and spray nozzle, directly on the silage in the silo as it is filled, or, preferably, it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

COVERING THE SILAGE.

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to shut off the air from the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled; if this is done, no covering is necessary and there should be no loss on account of spoiling.

On many dairy farms, however, the silage is not fed rapidly enough to keep the top layer from spoiling, which is especially liable to happen in summer, when the cows are on pasture and consuming little, if any, silage. As a means of preventing loss of that kind the Missouri Agricultural Experiment Station uses and recommends the use of a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls by means of a circular iron frame. By means of a pulley and the necessary attachments the canvas can be readily raised or lowered.

COST OF GROWING AND SILOING CORN.

Because of the wide variations in the yields per acre and in the cost of land and labor which are found in the corn-growing sections of the United States, it is not possible to give any figures on the cost of silage which are suitable for general application. Even if these items were uniform the yearly fluctuations in the cost of twine and fuel (gasoline, kerosene, coal, or wood) and other incidentals are such as to make it impossible to forecast the exact cost of silage in

any particular instance. If, however, the various items of expense on one farm are enumerated it should be possible to determine approximately the cost of silage on other farms even though some of the conditions vary widely.

Tables 5 and 6 were compiled from data kept at the Dairy Division Farm, Beltsville, Md., where detailed records are kept on the cost of all farm operations. They are not given as representative of the exact cost of silage in other sections or even on other farms in the locality. The data apply to the complete cost of growing and siloing 65.76 acres of corn, yielding by actual weight at time of siloing 670.46 tons of silage, or an average of 10.19 tons an acre. Of the 65.76 acres, 29.3 were grown in 1915 and cut with a corn harvester. The corn on the remaining 36.46 acres, grown in 1916, was so badly lodged that it was necessary to cut it by hand. A 15–30 horsepower kerosene tractor was used to run the cutter, and was also used to plow a part of the land preparatory to planting the corn.

Land was arbitrarily valued at $100 an acre. All other items included in the tables are taken directly from the farm records. Board and room were not furnished to employees. The only known factors not considered were taxes, insurance, and the manager's time.

TABLE 5.—*Cost of growing 65.76 acres of corn for silage.*

Man hours, 2,377.4, at 18.39 cents	$437.32
Mule hours, 2,385.7, at 8.4 cents	200.38
Interest on tractor, 65.8 hours, at 20 cents	13.16
Depreciation on tractor, 65.8 hours, at $1	65.80
Supplies for tractor	25.83
Interest on land, $100 an acre, at 5 per cent	328.81
Commercial fertilizer and limestone, 91.79 tons	688.68
Barnyard manure, 280.03 tons, at $3 (one-half value first year)	420.05
Seed corn, 13.15 bushels, at $2.444	32.16
	2,212.19
Cost per acre	33.64
Cost per ton	3.30

TABLE 6.—*Cost of harvesting and siloing 65.76 acres of corn.*

Man hours, 2,653.5, at 19.34 cents an hour	$513.32
Mule hours, 1,249, at 8.4 cents an hour	104.90
Binder twine, 145.3 pounds, at 11¾ cents a pound	17.07
Tractor supplies, gasoline, and oil	70.06
Interest on tractor, 202 hours, at 20 cents	40.40
Depreciation on tractor, 202 hours, at 50 cents	101.00
Interest on corn harvester, 54.6 hours, at 4.2 cents	2.29
Depreciation on corn harvester, 54.6 hours, at 20.8 cents	11.36
Interest on cutter, 202 hours, at 8 cents	16.16
Depreciation on cutter, 202 hours, at 40 cents	80.80
Interest on 3 wagons, 3 racks, 3 sets double harness	1.13
Depreciation on 3 wagons, 3 racks, 3 sets double harness	4.66
	963.15
Cost per acre	14.65
Cost per ton	1.44

Investigations of 21 farms in the State of New York, reported in Bulletin 377 of the Cornell Agricultural Experiment Station, showed that the interest and depreciation charges on silos amounted to 24 cents a ton annually, which, added to $1.44, makes a cost of $1.68 for harvesting, siloing, and storing. This, added to the $3.30 for growing, gives a total cost of $4.98 a ton for silage when stored in the silo

The use of both barnyard manure and commercial fertilizer for growing a crop of corn may be regarded as an exception to the general practice among farmers. As shown in Table 5, $688.68 was expended for fertilizer, and the cost of applying it was $107.62. While the latter expense is not mentioned as a separate item in Table 5, it is included in the charges for man and mule labor. Accordingly, the total cost of the fertilizer was $796.30. Had it been possible to obtain the same yields per acre and to maintain the fertility of the soil without the commercial fertilizer, the cost of the silage would have been reduced to $3.79 a ton.

Some varieties of corn, of which the Eureka is an example, have a high percentage of stalks and leaves and usually yield more per acre, and in consequence lower the cost of silage per ton. As a rule, however, such varieties produce a poorer quality of silage. Then again the tons per acre vary with the stage of maturity. It is evident, therefore, that any figures on either the cost or the feeding value of silage should take into account the kind of corn grown and its condition at the time of harvesting.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in Table 7 show the average quantity of digestible nutrients in 100 pounds of silage and other succulent feeds.

TABLE 7.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds.*

[From "Feeds and Feeding," by Henry and Morrison.]

Crop.	Total dry matter.	Digestible dry matter.			True protein.	Net energy value.
		Crude protein.	Carbohydrates.	Fat.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Therms.*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.06
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder	24.9	.7	14.1	.6	.4	15.37
Sorghum silage	22.8	.6	11.6	.5	.....	.....
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	27.8	1.3	9.5	.5	.8	7.26
Uncured soy bean	23.6	3.2	10.2	.5	2.4	12.53
Soy-bean silage	27.1	2.6	11.0	.7	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	22.0	1.8	10.1	.6	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6	.....	.....
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	10.0	.8	6.5	.3	.5	9.32
Prickly pear	16.5	.4	8.9	.2	.....	.....

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the Corn Belt refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

T. E. WOODWARD and J. B. MCNULTY, *of the Dairy Division.*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous upon farms devoted to dairying than upon farms of any other kind. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. However, a ration, of silage and legume hay without grain is satisfactory only for cows which are dry or which give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED.

The quantity of silage to feed a cow depends upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller dairy cows eat from 20 to 30 pounds a day and the larger as much as 40 or more.

RATIONS.

In general, dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day, or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in

the proportion of about 2.5 to 3.0 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 4 pounds of milk produced in addition to roughage will prove to be about right. For Jerseys 1 pound for each 2½ to 3 pounds of milk will come nearer to meeting the requirements. The grain for other breeds varies between these two according to the quality of milk produced. A good rule is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of first-class legume hay little grain is needed for cows of ordinary production. Alfalfa especially, if fed liberally, will enable the feeder to reduce the grain allowance to the minimum.

TIME TO FEED.

The time to feed silage is directly after milking. If this is impossible, it may be fed several hours before milking. In such cases there is a chance that the silage odor may taint the milk. On the other hand, if feeding is done after milking the odors from the silage will have disappeared before the next milking hour. Silage is usually fed twice, although sometimes three times a day.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before using, after which it should be fed immediately, that is, before decomposition sets in. No harm will result from feeding silage handled in this manner, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume more than one-half as much as mature stock, that is, 20 or more pounds a day if they are well grown. When supplemented with some good leguminous hay little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this quantity silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Cows when dry consume almost as much roughage as when they are at the pail. Silage may well form the principal ingredient of their

ration; in fact, with from 25 to 40 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. The quantities to feed depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES.

GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been fed generally to horses, partly because of a certain degree of danger in its use, but still more, perhaps, on account of prejudice. In many cases horses have been killed by eating moldy silage, and the careless person who fed it at once blamed the silage rather than his own carelessness and the mold, which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions varieties of mold which are deadly poisons to both horses and mules are found on silage. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warmer, he can soon detect the presence of mold. When mold appears he should immediately stop feeding the silage to horses or mules.

It is also unsafe to feed horses frozen silage because of the danger of colic. It is practically impossible to avoid frozen silage in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be carefully tramped and packed while filling. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is liable to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which may be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it and the daily consumption is so large as to preclude the formation of mold on the surface.

Good corn silage is a splendid feed for cheapening the ration for idle horses in winter. If the grain goes into the silo with the stover no additional grain is needed for them, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds of silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases in which stallions receive rations of silage, but has had no experience in feeding them in this manner. There seems to be no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should be useful also for young horses, especially drafters, but here again the writer can not quote his own experience, and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn properly stored in the silo. When it is properly stored and is not allowed to mold, no feed excels it as

a cheap winter ration. With plenty of grain on the cornstalk horses have been kept in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

E. W. SHEETS, *of the Animal Husbandry Division.*

There is no roughage which occupies a place of more importance in the economical feeding of beef cattle than silage. The increased value of all roughages as well as of grain has correspondingly increased the value of silage in its various forms for beef production. While silage is not a cheap feed it is in most cases a great saver of grain as well as other feeds whether fed to breeding stock, growing animals, or fattening cattle.

SILAGE FOR THE BREEDING HERD.

Silage, when available, should form the principal part of the winter ration for the breeding herd. Cows and calves relish it and thrive upon it when some supplement is added. Silage in the ration creates an appetite for less palatable and cheaper roughages, especially for the dry cows, thus reducing the cost of wintering. Good legume hays as a rule should be fed to the cows suckling calves unless a protein concentrate, such as cottonseed meal or oil meal, is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain their weight.

TABLE 8.—*Suggested rations for wintering beef cows.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc)	6 to 8	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	6 to 8	.....	.....
Cereal straw (oat, wheat, rye, etc.)	2 to 4	2 to 4	8 to 10	.....
Protein concentrate (oil meal, cottonseed meal, etc.)	.....	½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughages, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be largely determined by the quality of the silage. If there is little mature corn in the silage or if the mature corn was removed before filling the silo, it is necessary to give more silage or to supplement it with other or more nutritious feeds.

Uniformly good results are obtained in feeding breeding bulls one-half as much silage per head as is given to cows. As in the ration for breeding cows a small amount of grain should be supplied in addition to the amount of silage used, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES.

Before they are weaned calves should be fed silage only in limited quantities. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little weight during the weaning period. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay. A calf will eat the coarser, cheaper roughages but as a rule will give greater returns than older cattle from the use of better feeds and dry roughages, such as clover, alfalfa, and lespedeza.

A small quantity of grain should also be given for best results, together with a very little oil meal, peanut meal, or cottonseed meal.

The following rations will keep calves weighing from 400 to 600 pounds growing in a thrifty condition and allow considerable gain during the winter:

TABLE 9.—*Suggested rations for wintering beef calves.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	15 to 20	15 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	4 to 6	.....	.....
Cereal straw (oat, wheat, etc.)	.....	.....	4 to 6	.....
Protein concentrates (oil meal, cottonseed meal, etc.)	.....	½ to ½	½ to 1	¾ to 1½

SILAGE FOR WINTERING STOCKERS.

The ration for wintering stockers or feeders depends largely upon the feeds available. While silage is undoubtedly one of the best feeds for wintering stockers of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do breeding cows or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Many, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better

advantage than other cattle except possibly dry cows: When such silage is used it should be fed more liberally than where no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is desirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price and grain comparatively cheap, it may be advisable to limit the dry roughage to a few pounds and greatly increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, oil meal, or velvet beans. The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals.

TABLE 10.—*Suggested rations for wintering yearling stockers and feeders.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	3 to 4	.....	.....
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	.....
Protein concentrate (cottonseed meal, oil meal, etc.)	.....	½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are especially adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of silage fed. The dry roughages should also be increased accordingly from 3 to 5 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE.

Silage is almost indispensable in the ration for fattening cattle. The feeding of silage came into use with the advent of high-priced grain and has become more popular each year. With the price of grain as well as roughages remaining as it has been for several years there are few rations that can not be very greatly cheapened and benefited by the addition of silage in liberal amounts in some form or other, especially at the beginning of the feeding period.

Results of recent experimental work indicate that steers can be brought to a satisfactory finish on a ration which includes but little grain, except that which is fed in the silage. In such cases the silage should provide the basis of the ration, the steers being allowed as

much as they will eat, supplemented by cottonseed meal or oil meal with alfalfa or clover hay in addition. The rate of daily gain and the degree of finish attained by steers fed in this manner have been found to be only slightly below the gain and finish made by steers fed rations containing considerably more grain. It is at once evident, however, that the silage used must be of good quality and no mature ears whatever removed in order to insure the most satisfactory results. This ration probably will become extensively used in time, as it is more than likely that the bulk of the beef of the future will be eaten with less fat than formerly.

For 1,000-pound fattening animals the following average rations should be found satisfactory:

TABLE 11.—*Suggested rations for fattening cattle.*

Feeds fed.	Average daily amount of feed.[1]				
	Ration 1.	Ration 2.	Ration 3.	Ration 4.	Ration 5.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8	.....	.....	1½ to 2
Nonlegume hay (grass, hay, also stover)	.....	.....	4 to 6	6 to 8	.....
Protein concentrate,[2] cottonseed meal, oil meal, etc.	2 to 3	.....	3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10	.....	.....

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found aproximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts given but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP.

F. R. MARSHALL, *in charge of Sheep and Goat Investigations, Animal Husbandry Division.*

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. These beliefs are unfounded, and it has been proved by different experiment stations in tests with both breeding and feeder lambs that silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK.

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be retained in the ration.

Silage shows the best results when fed with a good legume hay. A satisfactory ration for a breeding ewe would consist of the following:

	Pounds.
Corn silage	3 to 4
Clover or alfalfa hay	1 to 2

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable.

SILAGE FOR LAMBS.

In fattening lambs corn silage not only saves hay and grain, but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume

about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds.
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.12

In wintering ewe lambs silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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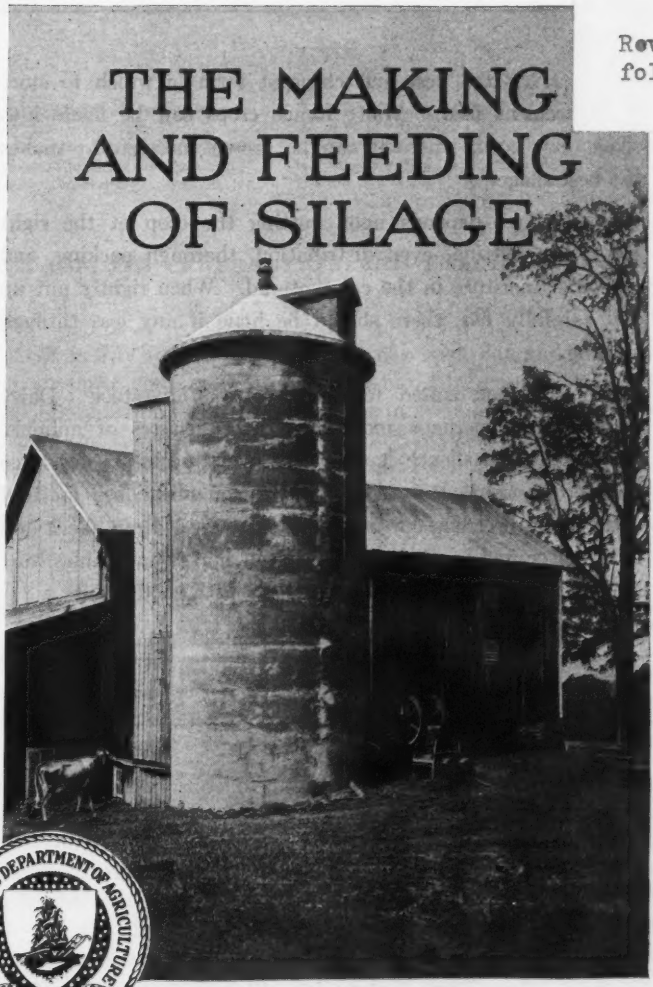
THE MAKING AND FEEDING OF SILAGE



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

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THE MAKING AND FEEDING OF SILAGE.

T. E. WOODWARD and J. B. MCNULTY, *Dairy Division*, and GEORGE M. ROMMEL, E. W. SHEETS, and F. R. MARSHALL, *Animal Husbandry Division*, *Bureau of Animal Industry*.[1]

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SILAGE, ITS PREPARATION AND FEEDING VALUE.

T. E. WOODWARD and J. B. MCNULTY, *of the Dairy Division*.

SILAGE is any fodder or grass that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition. Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter, or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Live stock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, healthy appearance than those fed exclusively on dry rations.

CROPS SUITABLE FOR SILAGE.

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, of which legumes are examples, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as the saccharine sorghums, have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

[1] Mr. McNulty resigned from the department August 26, 1919, and Mr. Rommel October 31, 1921.

CORN.

Corn is the common silage crop wherever it can be grown successfully. Silage made from it contains a high percentage of digestible nutrients, has a good flavor, is very palatable, and will keep in good condition for years. When it is properly siloed the losses of digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost 15.6 per cent of the dry matter, against 23.8 per cent when cut for fodder and cured in the field.[1] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since live stock need dry roughage, it is usually most satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT.

Since there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutriment than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

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[1] A Book on Silage, F. W. Woll, 1900.

TABLE 1.—*Yield per acre of digestible matter in corn.*

Constituents.	Yield per acre.		
	Ears.	Stover.	Total crop.
	Pounds.	*Pounds.*	*Pounds.*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

FIG. 1.—A fine crop of corn for silage.

METHODS OF PLANTING.

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 or 8 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recommended for weedy land. If serious trouble with weeds is expected

the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain so high a percentage of digestible nutrients as in thin planting. At the Dairy Division farm, Beltsville, Md., it was found that corn planted at the rate of 4 stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of 2 stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on poor soil.

YIELD.

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed.

The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST.

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant.*

Yield per acre.	Stage of growth.				
	Tasseled, July 30.	Silked, Aug. 9.	Milk, Aug. 21.	Glazed, Sept. 7.	Ripe, Sept. 23.
Total yield	*Pounds.* 18,045.00	*Pounds.* 25,745.00	*Pounds.* 32,600.00	*Pounds.* 32,295.00	*Pounds.* 28,460.00
Water	16,426 00	22,666 00	27,957.00	25,093.00	20,542.00
Dry matter	1,619 00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138 91	201 30	232.15	302 48	364.23
Albuminoids	239.77	436 76	478.69	643.86	677.78
Crude fiber	514 19	872 93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653 91	1,399 26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN.

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix the corn with some which is more mature. Silage from immature corn will be sourer than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack and keep properly.

DRY CORN FODDER.

Sometimes there is a delay in filling the silo, and it is necessary to cut and shock the corn. On farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out.

Dry corn fodder may be siloed successfully, but it is absolutely necessary that a sufficient quantity of water be added to wet it enough so that it will pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower while filling. In addition it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[1] . Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

[1] Circular No. 71, Missouri Agricultural Experiment Station

SORGHUMS.

Saccharine sorghums, such as amber cane and orange cane, and nonsaccharine sorghums, such as kafir, feterita, milo, and Sudan grass, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard.

FIG. 2.—Shock corn, if properly handled, will make fair silage.

If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas [1] and California [2] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

LEGUMES.

The legumes include the clovers, sweet clover, alfalfa, cowpea, soy beans, velvet beans, and the vetches. All such forage crops, if prop-

[1] Circular 28, Kansas Agricultural Experiment Station.
[2] Bulletin 282, California Agricultural Experiment Station.

erly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums. It has been reported [1] that when ordinary blackstrap molasses was added to alfalfa silage at the rate of 1 part to 20 by weight there was a very marked improvement in the flavor, palatability, and keeping qualities of the silage. Most legumes should be cut for silage at the same time as for hay.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage.

Cowpeas and soy beans may be siloed separately, but generally they are used in combination with corn or sorghum. They are grown either in separate fields or with the corn. Cowpeas when grown with corn climb the stalks and make harvesting difficult. Soy beans being self-supporting can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soy beans make a more satisfactory crop to grow with the corn. Some authorities assert that soy beans grown with corn do not lower the yield of corn, but an experiment on the Dairy Division farm at Beltsville, Md., indicates otherwise. Probably the most desirable plan is to grow the legumes in separate fields, and mix them with the corn at silo-filling time.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS.

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo.

The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the

[1] O. E. Reed in Hoard's Dairyman, Mar. 16, 1917.

early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage is especially liable to affect the flavor of milk.

FIELD PEAS AND OATS.

Peas and oats planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut this crop for silage is when the oats begin to pass from the milk into the dough stage, and when the pea pods have fair-sized peas in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats are siloed together.

MILLET.

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES.

Pea vines from canning factories are used extensively for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS.

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it

damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to make the silo as nearly air-tight as possible. Other coarse roughages, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

RAPE.

If harvested when nearly mature but still succulent, rape makes a silage of fair quality. It can be put in the silo with mature corn or sorghum, legumes, or straw, and thus produce a good grade of silage. A mixture of rape and alfalfa, clover, or sweet clover makes the best silage, being somewhat better than legumes alone, as the rape contains sugars which are lacking in legumes.

CANE TOPS AND CANE BAGASSE.

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS.

Sunflowers are coming into more general use on the irrigated lands of the West and Northwest, where the weather is too cool and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn. As high as 29.75 tons to the acre have been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

MISCELLANEOUS CROPS.

Beet pulp, apple pomace, Russian thistles, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO.

Corn or sorghums for the silo may be cut by hand, with the sled cutter, or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods, the cost per acre of cutting corn was found to be

FIG. 3.—A corn harvester at work.

lowest when the sled cutter was used.[1] All things considered, however, the corn harvester is a more satisfactory method of cutting corn for the silo.

In using the corn harvester the bundles should be made rather small. While this takes more twine the extra expense is more than offset by the ease of handling the bundles and in feeding them into the silage cutter. Two to four horses and one man will be required to run the harvester, which should cut about 6 acres a day. The harvester should not get so far ahead of the haulers that the corn will lose any considerable moisture before it is hauled to the cutter.

HAULING TO THE CUTTER.

The corn ordinarily is hauled to the cutter with the common flat hay frames. An objection to their use is the hard work necessary

[1] See Bulletin 145, Nebraska Agricultural Experiment Station.

to lift the green corn fodder so high in loading. A low-wheeled wagon is much preferable to a high-wheeled one. A low hayrack very commonly used in some parts of the United States can easily be made. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, "Cost of Filling Silos":

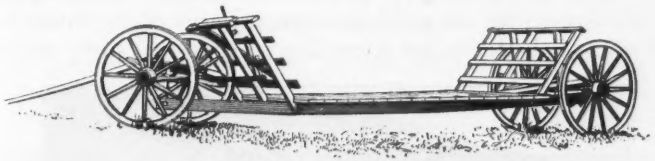

FIG. 4.—A low rack suitable for hauling corn to cutter.

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

FIG. 5.—Hauling corn to the silage cutter.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading, and facilitating the work of unloading.

CUTTING THE SILAGE.

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity of the machine to be purchased is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine so large that every one will

FIG. 6.—Silage cutter with chain carrier.

be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes lack. Other factors to be taken into account in purchasing a cutter are the amount of work to be done and the power available.

LENGTH TO CUT.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so

closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand the longer the pieces the more rapidly the corn can be run through the cutter. The bulk of the silage is now cut into pieces less than 1 inch in length. Fine cutting and good tramping are needed if it is desired to make the best quality of silage and fill the silo to its greatest capacity.

ELEVATING THE SILAGE.

Two types of elevators are in use, the old-style chain carrier and the blower (see figs. 6 and 7). The chain carrier requires less power but is harder to set up and makes more litter, especially in windy

FIG. 7.—Silage cutter with blower.

weather. Some chain carriers are so inclosed as to keep the corn from blowing out. In using the blower type the blower should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

POWER REQUIRED.

The power necessary to operate the cutter depends upon length of knives, sharpness of knives, type of elevator, height of the silo, the rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed slowly than if fed to full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. Tables 3 and 4 give the power required for blowers and carriers,

respectively, when gas engines are used. The figures given are thought to represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy well-eared corn. If power is furnished by a steam engine the horsepower may be reduced 25 per cent, and if by an electric motor the horsepower is reduced 15 per cent. The tables have been prepared from manufacturers' statements, personal observations, and experience, and are not the result of actual experimental tests.

TABLE 3.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

TABLE 4.—*Horsepower (gas engine) required to operate silage cutter and chain carrier, with varying lengths of cutting knives and varying heights of silos.*

Length of knives.	Height of silo—feet.														Approximate capacity.
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower.														
															Tons per hour.
10	2.5	2.6	2.6	2.7	2.9	2.9	2.9	3.0	3.1	3.1	3.1	3.2	3.2	3.3	3
12	4.4	4.5	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.1	5.1	5.2	5.2	3
14	6.4	6.5	6.5	6.6	6.7	6.7	6.8	6.8	7.0	7.0	7.1	7.1	7.2	7.2	5
16	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	8
18	10.5	10.7	10.9	11.7	11.1	11.3	11.4	11.6	11.7	11.8	12.0	12.1	12.2	12.4	10
20	13.0	13.1	13.4	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.4	14.6	14.7	14.9	12

If a steam engine is used for driving the cutter the above horsepower may be reduced 25 per cent. If an electric motor is used decrease the above horsepower 15 per cent.

PACKING THE SILAGE.

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping

the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being loosely put together can be swung so as to place the material anywhere in the silo (see fig. 8). With this contrivance it is not necessary to handle the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some foreign object which might pass up the blower pipe. As the silage rises in the silo the distributer pipe, which is put together in sections, can be readily shortened as required.

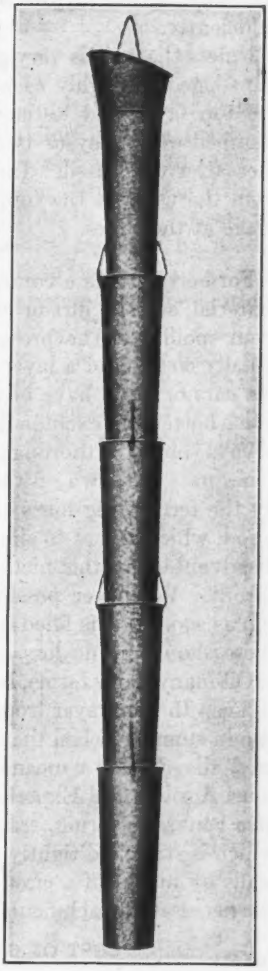

FIG. 8.—Jointed-pipe silage distributer.

A canvas distributer consisting of a tube of canvas fitted over rings can be made with little trouble and at lower cost than the pipe distributer. A distributer of that kind can be rolled up and usually gives good service.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER.

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will "firefang" or deteriorate through the growth of mold. Water enough should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied, by means of a hose and spray nozzle, directly on the silage in the silo as it is filled, or, preferably, it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

COVERING THE SILAGE.

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to shut off the air from the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled; if this is done, no covering is necessary and there should be no loss on account of spoiling.

On many dairy farms, however, the silage is not fed rapidly enough to keep the top layer from spoiling, which is especially liable to happen in summer, when the cows are on pasture and consuming little, if any, silage. As a means of preventing loss of that kind the Missouri Agricultural Experiment Station uses and recommends the use of a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls by means of a circular iron frame. By means of a pulley and the necessary attachments the canvas can be readily raised or lowered.

COST OF GROWING AND SILOING CORN.

Because of the wide variations in the yields per acre and in the cost of land and labor which are found in the corn-growing sections of the United States, it is not possible to give any figures on the cost of silage which are suitable for general application. Even if these items were uniform the yearly fluctuations in the cost of twine and fuel (gasoline, kerosene, coal, or wood) and other incidentals are such as to make it impossible to forecast the exact cost of silage in

any particular instance. If, however, the various items of expense on one farm are enumerated it should be possible to determine approximately the cost of silage on other farms even though some of the conditions vary widely.

Tables 5 and 6 were compiled from data kept at the Dairy Division Farm, Beltsville, Md., where detailed records are kept on the cost of all farm operations. They are not given as representative of the exact cost of silage in other sections or even on other farms in the locality. The data apply to the complete cost of growing and siloing 65.76 acres of corn, yielding by actual weight at time of siloing 670.46 tons of silage, or an average of 10.19 tons an acre. Of the 65.76 acres, 29.3 were grown in 1915 and cut with a corn harvester. The corn on the remaining 36.46 acres, grown in 1916, was so badly lodged that it was necessary to cut it by hand. A 15–30 horsepower kerosene tractor was used to run the cutter, and was also used to plow a part of the land preparatory to planting the corn.

Land was arbitrarily valued at $100 an acre. All other items included in the tables are taken directly from the farm records. Board and room were not furnished to employees. The only known factors not considered were taxes, insurance, and the manager's time.

TABLE 5.—*Cost of growing 65.76 acres of corn for silage.*

Man hours, 2,377.4, at 18.39 cents	$437.32
Mule hours, 2,385.7, at 8.4 cents	200.38
Interest on tractor, 65.8 hours, at 20 cents	13.16
Depreciation on tractor, 65.8 hours, at $1	65.80
Supplies for tractor	25.83
Interest on land, $100 an acre, at 5 per cent	328.81
Commercial fertilizer and limestone, 91.79 tons	688.68
Barnyard manure, 280.03 tons, at $3 (one-half value first year)	420.05
Seed corn, 13.15 bushels, at $2.444	32.16
	2,212.19
Cost per acre	33.64
Cost per ton	3.30

TABLE 6.—*Cost of harvesting and siloing 65.76 acres of corn.*

Man hours, 2,653.5, at 19.34 cents an hour	$513.32
Mule hours, 1,249, at 8.4 cents an hour	104.90
Binder twine, 145.3 pounds, at 11¾ cents a pound	17.07
Tractor supplies, gasoline, and oil	70.06
Interest on tractor, 202 hours, at 20 cents	40.40
Depreciation on tractor, 202 hours, at 50 cents	101.00
Interest on corn harvester, 54.6 hours, at 4.2 cents	2.29
Depreciation on corn harvester, 54.6 hours, at 20.8 cents	11.36
Interest on cutter, 202 hours, at 8 cents	16.16
Depreciation on cutter, 202 hours, at 40 cents	80.80
Interest on 3 wagons, 3 racks, 3 sets double harness	1.13
Depreciation on 3 wagons, 3 racks, 3 sets double harness	4.66
	963.15
Cost per acre	14.65
Cost per ton	1.44

Investigations of 21 farms in the State of New York, reported in Bulletin 377 of the Cornell Agricultural Experiment Station, showed that the interest and depreciation charges on silos amounted to 24 cents a ton annually, which, added to $1.44, makes a cost of $1.68 for harvesting, siloing, and storing. This, added to the $3.30 for growing, gives a total cost of $4.98 a ton for silage when stored in the silo

The use of both barnyard manure and commercial fertilizer for growing a crop of corn may be regarded as an exception to the general practice among farmers. As shown in Table 5, $688.68 was expended for fertilizer, and the cost of applying it was $107.62. While the latter expense is not mentioned as a separate item in Table 5, it is included in the charges for man and mule labor. Accordingly, the total cost of the fertilizer was $796.30. Had it been possible to obtain the same yields per acre and to maintain the fertility of the soil without the commercial fertilizer, the cost of the silage would have been reduced to $3.79 a ton.

Some varieties of corn, of which the Eureka is an example, have a high percentage of stalks and leaves and usually yield more per acre, and in consequence lower the cost of silage per ton. As a rule, however, such varieties produce a poorer quality of silage. Then again the tons per acre vary with the stage of maturity. It is evident, therefore, that any figures on either the cost or the feeding value of silage should take into account the kind of corn grown and its condition at the time of harvesting.

FEEDING VALUE OF SILAGE.

COMPOSITION.

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. The figures in Table 7 show the average quantity of digestible nutrients in 100 pounds of silage and other succulent feeds.

TABLE 7.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds.*

[From "Feeds and Feeding," by Henry and Morrison.]

Crop.	Total dry matter.	Digestible dry matter.			True protein.	Net energy value.
		Crude protein.	Carbohydrates.	Fat.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Therms.*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.06
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder	24.9	.7	14.1	.6	.4	15.37
Sorghum silage	22.8	.6	11.6	.5	.....	.....
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	27.8	1.3	9.5	.5	.8	7.26
Uncured soy bean	23.6	3.2	10.2	.5	2.4	12.53
Soy-bean silage	27.1	2.6	11.0	.7	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	22.0	1.8	10.1	.6	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6	.....	.....
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	10.0	.8	6.5	.3	.5	9.32
Prickly pear	16.5	.4	8.9	.2	.....	.....

PALATABILITY.

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the Corn Belt refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

SILAGE FOR DAIRY CATTLE.

T. E. Woodward and J. B. McNulty, *of the Dairy Division.*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous upon farms devoted to dairying than upon farms of any other kind. In many sections silage has come to be the dairy farmer's main reliance for cow feed in winter.

SUPPLEMENTARY FEEDS.

While silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. However, a ration, of silage and legume hay without grain is satisfactory only for cows which are dry or which give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED.

The quantity of silage to feed a cow depends upon the capacity of the animal to consume feed. She should be fed as much as she will clean up without waste when consumed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller dairy cows eat from 20 to 30 pounds a day and the larger as much as 40 or more.

RATIONS.

In general, dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day, or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in

the proportion of about 2.5 to 3.0 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 4 pounds of milk produced in addition to roughage will prove to be about right. For Jerseys 1 pound for each 2½ to 3 pounds of milk will come nearer to meeting the requirements. The grain for other breeds varies between these two according to the quality of milk produced. A good rule is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of first-class legume hay little grain is needed for cows of ordinary production. Alfalfa especially, if fed liberally, will enable the feeder to reduce the grain allowance to the minimum.

TIME TO FEED.

The time to feed silage is directly after milking. If this is impossible, it may be fed several hours before milking. In such cases there is a chance that the silage odor may taint the milk. On the other hand, if feeding is done after milking the odors from the silage will have disappeared before the next milking hour. Silage is usually fed twice, although sometimes three times a day.

FEEDING FROZEN SILAGE.

Frozen silage must be thawed before using, after which it should be fed immediately, that is, before decomposition sets in. No harm will result from feeding silage handled in this manner, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS.

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume more than one-half as much as mature stock, that is, 20 or more pounds a day if they are well grown. When supplemented with some good leguminous hay little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is any scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds of silage a day for each 1,000 pounds of live weight. When fed in this quantity silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Cows when dry consume almost as much roughage as when they are at the pail. Silage may well form the principal ingredient of their

ration; in fact, with from 25 to 40 pounds of silage and a small supplementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING.

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. The quantities to feed depend upon the condition of the pastures, varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES.

GEORGE M. ROMMEL, *Chief of the Animal Husbandry Division.*

Silage has not been fed generally to horses, partly because of a certain degree of danger in its use, but still more, perhaps, on account of prejudice. In many cases horses have been killed by eating moldy silage, and the careless person who fed it at once blamed the silage rather than his own carelessness and the mold, which really was the cause of the trouble. Horses are peculiarly susceptible to the effects of molds, and under certain conditions varieties of mold which are deadly poisons to both horses and mules are found on silage. Molds must have air to grow and therefore silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warmer, he can soon detect the presence of mold. When mold appears he should immediately stop feeding the silage to horses or mules.

It is also unsafe to feed horses frozen silage because of the danger of colic. It is practically impossible to avoid frozen silage in very cold weather, especially in solid-wall silos. By taking the day's feed from the unfrozen center of the silo and chopping away the frozen silage from the edges and piling the frozen pieces in the center the mass will usually thaw out in time for the next feed.

Corn to be made into silage for horses should not be cut too green, as sour silage will result and may cause colic when fed. The corn should be well matured and cut when the grain is beginning to glaze. The silo should be filled rapidly and the corn should be carefully tramped and packed while filling. This is by far the most important point in connection with feeding silage to horses, and the lives of the horses fed on silage may depend on the thoroughness with which the tramping is done. If properly done no danger is liable to result; if not properly done air pockets may form and cause the accumulation of a small mass of mold which the feeder may overlook but which may be sufficient to kill one or more horses.

The value of silage for horses is greatest as a means to carry them through the winter cheaply or to supplement pasture during drought. As the danger of mold is greater in summer than in winter, silage should not be fed to horses in that season unless a large number of animals are getting it and the daily consumption is so large as to preclude the formation of mold on the surface.

Good corn silage is a splendid feed for cheapening the ration for idle horses in winter. If the grain goes into the silo with the stover no additional grain is needed for them, hay being the only supplementary feed necessary. If there is little grain on the corn the silage should be supplemented with 1 pound of old-process linseed-oil meal or cottonseed meal daily per 1,000 pounds live weight, sprinkled over the silage.

Horses to be wintered on a silage and hay ration should be started on about 5 pounds of silage daily per 1,000 pounds live weight, the grain and hay ration being gradually decreased as the silage is increased until the ration is 20 pounds of silage and 10 pounds of hay daily per 1,000 pounds live weight. It will require about a month to reach the full feed of silage, but the period may be decreased somewhat, depending on the judgment and skill of the feeder.

Work horses when idle can be wintered satisfactorily in this manner, but much silage is not recommended for horses at heavy work for the same reason that a driving horse can not do his best while on watery grass pasture.

The writer knows of cases in which stallions receive rations of silage, but has had no experience in feeding them in this manner. There seems to be no reason why silage should not be a valuable feed for stallions during the idle season.

Silage should be useful also for young horses, especially drafters, but here again the writer can not quote his own experience, and experimental data are meager.

To summarize, silage is safe to feed to horses and mules only when it is made from fairly mature corn properly stored in the silo. When it is properly stored and is not allowed to mold, no feed excels it as

a cheap winter ration. With plenty of grain on the cornstalk horses have been kept in good condition on a ration of 20 pounds of silage and 10 pounds of hay for each 1,000 pounds of live weight.

SILAGE FOR BEEF CATTLE.

E. W. SHEETS, *of the Animal Husbandry Division.*

There is no roughage which occupies a place of more importance in the economical feeding of beef cattle than silage. The increased value of all roughages as well as of grain has correspondingly increased the value of silage in its various forms for beef production. While silage is not a cheap feed it is in most cases a great saver of grain as well as other feeds whether fed to breeding stock, growing animals, or fattening cattle.

SILAGE FOR THE BREEDING HERD.

Silage, when available, should form the principal part of the winter ration for the breeding herd. Cows and calves relish it and thrive upon it when some supplement is added. Silage in the ration creates an appetite for less palatable and cheaper roughages, thus reducing the cost of wintering. Good legume hays as a rule should be fed to the cows suckling calves unless a protein concentrate, such as cottonseed meal or oil meal, is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain their weight.

TABLE 8.—*Suggested rations for wintering beef cows.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc)	6 to 8	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	6 to 8	.....	.....
Cereal straw (oat, wheat, rye, etc.)	2 to 4	2 to 4	8 to 10	.....
Protein concentrate (oil meal, cottonseed meal, etc.)	.....	½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughages, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be largely determined by the quality of the silage. If there is little mature corn in the silage or if the mature corn was removed before filling the silo, it is necessary to give more silage or to supplement it with other or more nutritious feeds.

Generally good results are obtained in feeding breeding bulls one-half as much silage per head as is given to cows. As in the ration for breeding cows a small amount of grain should be supplied in addition to the amount of silage used, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES.

Before they are weaned calves should be fed silage only in limited quantities. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little weight during the weaning period when they are liberally fed on grain, legume hay, and silage. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay. A calf will eat the coarser, cheaper roughages but as a rule will give greater returns than older cattle from the use of better feeds and dry roughages, such as clover, alfalfa, and lespedeza.

A small quantity of grain should also be given for best results, together with a very little oil meal, peanut meal, or cottonseed meal.

The following rations will keep calves weighing from 400 to 600 pounds growing in a thrifty condition and allow considerable gain during the winter:

TABLE 9.—*Suggested rations for wintering beef calves.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	15 to 20	15 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5	.....	.....	.....
Nonlegume hay (grass hays, also stover)	.....	4 to 6	.....	.....
Cereal straw (oat, wheat, etc.)	.....	.....	4 to 6	.....
Protein concentrates (oil meal, cottonseed meal, etc.)	.....	½ to ¾	½ to 1	¾ to 1½

SILAGE FOR WINTERING STOCKERS.

The ration for wintering stockers or feeders depends largely upon the feeds available. While silage is undoubtedly one of the best feeds for wintering stockers of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do breeding cows or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Many, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better

advantage than other cattle except possibly dry cows. When such silage is used it should be fed more liberally than where no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is desirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price and grain comparatively cheap, it may be advisable to limit the dry roughage to a few pounds and greatly increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, oil meal, or velvet beans. The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals.

TABLE 10.—*Suggested rations for wintering yearling stockers and feeders.*

Feeds fed.	Average daily amount of feed.			
	Ration 1.	Ration 2.	Ration 3.	Ration 4.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4			
Nonlegume hay (grass hays, also stover)		3 to 4		
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	
Protein concentrate (cottonseed meal, oil meal, etc.)		½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are especially adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of silage fed. The dry roughages should also be increased accordingly from 3 to 5 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE.

The feeding of silage came into use with the advent of high-priced grain and has become more popular each year. With the price of grain as well as roughages remaining as it has been for several years there are few rations that can not be very greatly cheapened and benefited by the addition of silage in liberal amounts in some form or other, especially at the beginning of the feeding period.

Results of recent experimental work indicate that steers can be brought to a satisfactory finish on a ration which includes but little grain, except that which is fed in the silage. In such cases the silage should provide the basis of the ration, the steers being allowed as

much as they will eat, supplemented by cottonseed meal or oil meal with alfalfa or clover hay in addition. The rate of daily gain and the degree of finish attained by steers fed in this manner have been found to be only slightly below the gain and finish made by steers fed rations containing considerably more grain. It is at once evident, however, that the silage used must be of good quality and no mature ears whatever removed in order to insure the most satisfactory results. This ration probably will become extensively used in time, as it is more than likely that the bulk of the beef of the future will be eaten with less fat than formerly.

For 1,000-pound fattening animals the following average rations should be found satisfactory:

TABLE 11.—*Suggested rations for fattening cattle.*

Feeds fed.	Average daily amount of feed.[1]				
	Ration 1.	Ration 2.	Ration 3.	Ration 4.	Ration 5.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Silage (corn or sorghum)	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8	.....	.....	1½ to 2
Nonlegume hay (grass, hay, also stover)	.....	.....	4 to 6	6 to 8	.....
Protein concentrate,[2] cottonseed meal, oil meal, etc.	2 to 3	.....	3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10	.....	.....

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found aproximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts given but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP.

F. R. MARSHALL, *in charge of Sheep and Goat Investigations, Animal Husbandry Division.*

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. These beliefs are unfounded, and it has been proved by different experiment stations in tests with both breeding and feeder lambs that silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK.

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be retained in the ration.

Silage shows the best results when fed with a good legume hay. A satisfactory ration for a breeding ewe would consist of the following:

	Pounds.
Corn silage	3 to 4
Clover or alfalfa hay	2 to 3

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable.

SILAGE FOR LAMBS.

In fattening lambs corn silage not only saves hay and grain, but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume

about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds.
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.12

In wintering ewe lambs silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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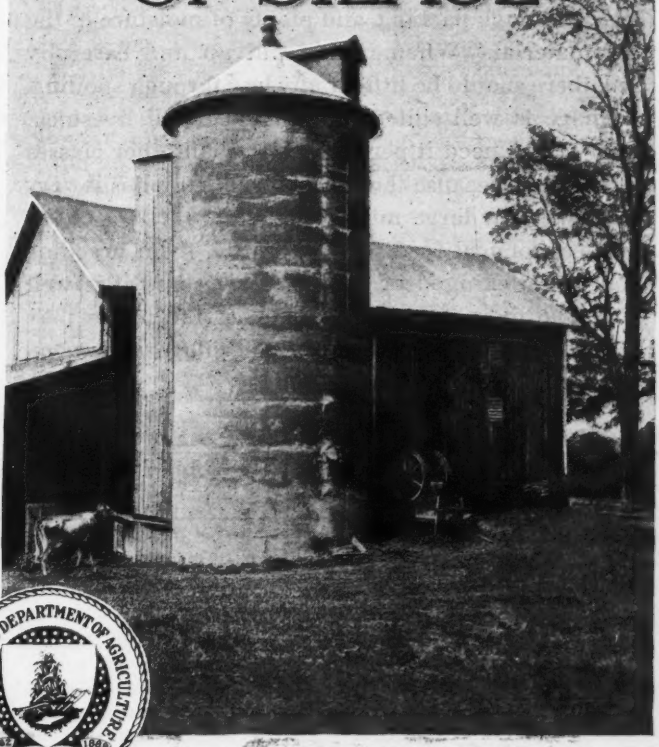
THE MAKING AND FEEDING OF SILAGE



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good quality in the silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

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THE MAKING AND FEEDING OF SILAGE

By T. E. Woodward and J. B. McNulty, *Bureau of Dairying;* and George M. Rommel, E. W. Sheets, and F. R. Marshall, *Bureau of Animal Industry*[1]

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MANUFACTURE AND FEEDING VALUE OF SILAGE

By T. E. Woodward and J. B. McNulty, *Bureau of Dairying*

SILAGE is any food material that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition.

Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Livestock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, more healthy appearance than those fed exclusively on dry rations.

CROPS SUITABLE FOR SILAGE

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, legumes for example, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as the sorgos, have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

CORN

Corn is the common silage crop wherever it can be grown successfully. (See fig. 1.) Silage made from corn has a good flavor, is very palatable, and will keep in good condition for years. It contains nearly as high a percentage of digestible nutrients as the corn from which it was made. When it is properly siloed, the losses of

[1] Mr. McNulty resigned from the department Aug. 26, 1919, and Mr. Rommel Oct. 31, 1921.

digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost about one-sixth of the dry matter against one-fourth when cut for fodder and cured in the field.[2] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is

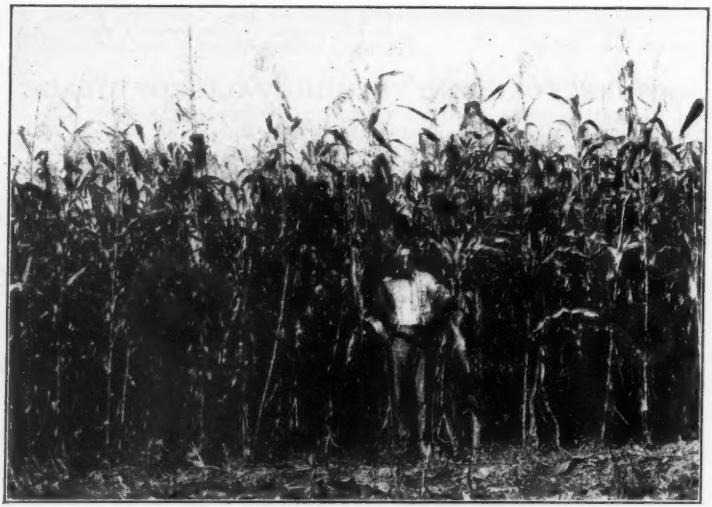

FIG. 1.—Well-eared corn makes silage of the best quality

husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, soybeans, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since livestock need dry roughage, it is usually more satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT

As there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature

[2] A Book on Silage, F. W. Woll, 1900.

sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutrient than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and leaves and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

TABLE 1.—*Yield per acre of digestible matter in corn*

Constituents	Yield per acre		
	Ears	Stover	Total crop
	Pounds	*Pounds*	*Pounds*
Protein	244	83	327
Carbohydrates	2,301	1,473	3,774
Fat	125	22	147
Total	2,670	1,578	4,248

METHODS OF PLANTING

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 to 10 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recommended for weedy land. If serious trouble with weeds is expected, the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain as high a percentage of digestible nutrients as in thin planting. At the farm of the Bureau of Dairying, Beltsville, Md., it was found that corn planted at the rate of four stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of two stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on poor soil.

YIELD

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed. The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 or 5½ bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90

per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant*

Yield per acre	Stage of growth				
	Tasseled, July 30	Silked, Aug. 9	Milk, Aug. 21	Glazed, Sept. 7	Ripe, Sept. 23
Total yield	*Pounds* 18,045.00	*Pounds* 25,745.00	*Pounds* 32,600.00	*Pounds* 32,295.00	*Pounds* 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	21,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	344.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix such corn with some which is more mature. Silage from immature corn will be more sour than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible, in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack properly.

DRY CORN FODDER

Sometimes there is a delay in filling the silo and it is necessary to cut and shock the corn; also, on farms which have a limited silo

capacity, it is often desired to refill the silos after the silage has been fed out. Dry corn fodder may be siloed successfully, but it is absolutely necessary that water enough be added to make it pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower or the top of the blower pipe while filling. In addition, it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. It also lacks the aroma of good corn silage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[3] Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

Corn stover likewise can be made into silage by the same methods. It lacks flavor and palatability and is low in feeding value. It is doubtful whether the making of such silage is an economical practice.

FIG. 2.—Shock corn, if properly handled, will make fair silage

SORGHUMS

Sorgos, such as Amber cane and Orange cane, and sorghums such as kafir, feterita, milo, and Sudan grass, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas[4] and California[5] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

[3] Circular No. 71, Missouri Agricultural Experiment Station.
[4] Circular 28, Kansas Agricultural Experiment Station.
[5] Bulletin 282, California Agricultural Experiment Station.

LEGUMES

The legumes include the clovers, alfalfa, cowpeas, soybeans, velvet beans, and the vetches. All such forage crops, if properly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums. It has been reported [6] that when ordinary blackstrap molasses is added to alfalfa silage at the rate of 1 part to 20 by weight there is a very marked improvement in the flavor, palatability, and keeping qualities of the silage. Most legumes should be cut for silage at the same time as for hay.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage.

Cowpeas and soybeans may be siloed separately, but generally they are used in combination with corn or sorghum. They are grown either in separate fields or with the corn. Cowpeas when grown with corn climb the stalks and make harvesting difficult. Soybeans being self-supporting can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soybeans make a more satisfactory crop to grow with the corn.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo. The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage especially is likely to affect the flavor of milk.

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[6] O. E. Reed in Hoard's Dairyman, Mar. 16, 1917.

FIELD PEAS AND OATS, OR VETCH AND WHEAT

Peas and oats or vetch and wheat planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut these crops for silage is when the oats or wheat begin to pass from the milk into the dough stage, and when the pea or vetch pods have fair-sized seeds in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats or vetch and wheat are siloed together.

MILLET

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES

Pea vines from canning factories are used for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to keep out the air. Other coarse roughage, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

CANE TOPS AND CANE BAGASSE

Tops from sugarcane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not as good as corn silage, can well be used in those sections where sugarcane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS

Sunflowers are used to some extent in the West and Northwest, where the weather is too cool and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn in some localities. As high as 29.75 tons to the acre has been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage

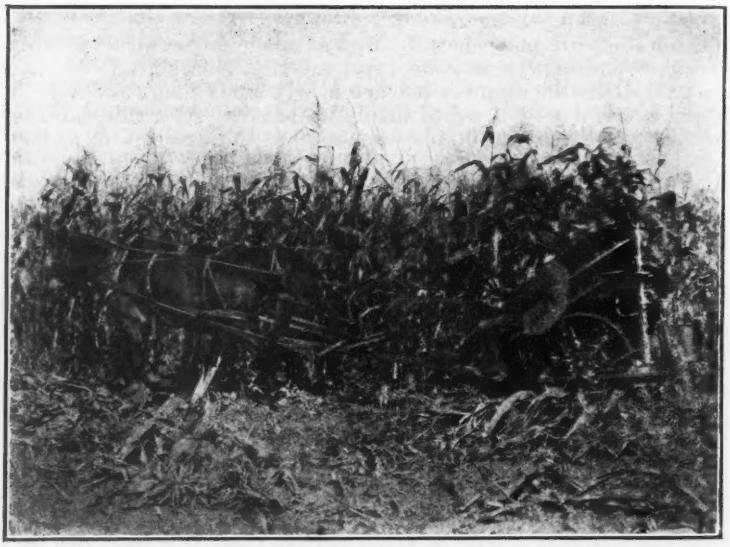

FIG. 3.—A corn harvester at work

will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

Opinions differ as to the feeding value of sunflower silage. In some experiments it seems to be practically equal to corn silage; in others it is inferior. Doubtless the stage of maturity at harvesting time of both the sunflowers and the corn has been partly responsible for this lack of uniformity in results. A composite of all experiments indicates that sunflower silage is neither so palatable nor so valuable, pound for pound, as corn silage, though it may be fully equal to some of the other kinds of silage.

MISCELLANEOUS CROPS

Beet pulp, apple pomace, Russian thistle, and corn husks from canning factories are also occasionally used for silage, but in general are not as satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO

Corn or sorghums for the silo may be cut by hand, with the sled cutter, or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods, the cost per acre of cutting corn was found to be lowest when the sled cutter was used.[7] All things considered, however, the corn harvester is more satisfactory.

In using the corn harvester the bundles should be made rather small. While this takes more twine, the extra expense is more than

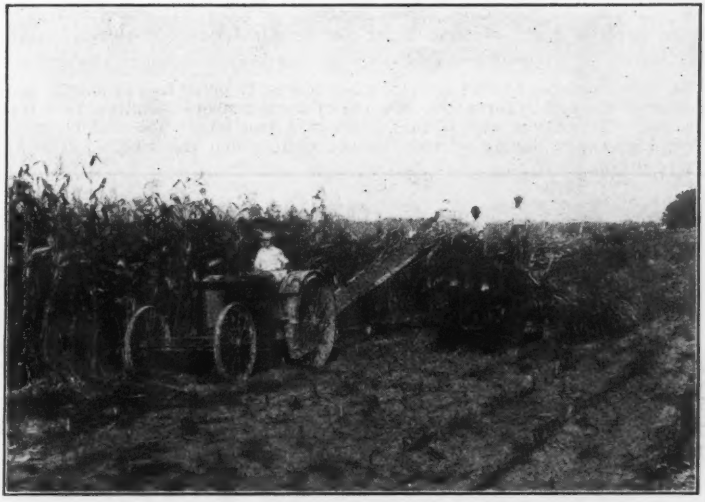

FIG. 4.—Tractor-drawn binder with elevator saves horses and men

offset by the ease of handling the bundles and feeding them into the silage cutter. Two to four horses and one man will be required to run the harvester, which should not get so far ahead of the haulers that the corn will lose any considerable amount of moisture before it is hauled to the cutter.

A bundle elevator which is attached to the corn harvester in place of the bundle carrier has come into use in the last few years. This elevator delivers the bundles to a wagon driven alongside the harvester. Its use eliminates the hardest part of the silo-filling operation. A load of 2 tons can be put on in 12 to 15 minutes. When the elevator is used the power necessary to pull the harvester is increased, and this fact, together with the need for a steady power, makes the use of a tractor desirable. (Fig. 4.)

[7] See Bulletin 145, Nebraska Agricultural Experiment Station.

HAULING TO THE CUTTER

Ordinarily the corn is hauled to the cutter on a common, flat hay rack. It is best to have this rack mounted on a low-wheeled wagon, even when used in connection with a harvester and elevator. Of course when the loading is done by hand a low-wheeled wagon is much more preferable than a high-wheeled one. (See figs. 5 and 6.)

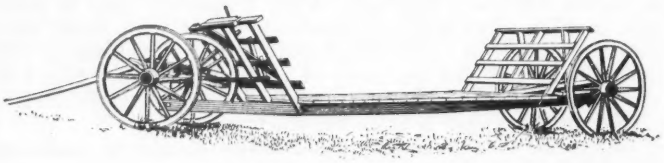

FIG. 5.—A low rack for hauling corn to cutter

A low rack or body can be made easily. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, "Cost of Filling Silos":

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex

FIG. 6.—Loading corn on the wagon, the hardest work of all

of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the

loads should be smaller, thus saving the labor of high lifting in loading. and facilitating the work of unloading.

CUTTING THE SILAGE

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that every one will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes often lack. Other factors to be taken into account are the amount of work to be done and the power to be used.

FIG. 7.—Silage cutter with blower

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand, the longer the pieces the more rapidly the corn can be run through the cutter. Probably most silage is now cut into pieces about half an inch long. Fine cutting and good tramping are needed to make the best quality of silage and fill the silo to greatest capacity.

ELEVATING THE SILAGE

Two types of elevators are in use, the old-style chain carrier and the blower. The chain carrier requires less power but is harder to set up and is not so well adapted for high silos. Some chain carriers are inclosed so as to keep the corn from blowing out. In using

the blower type the blower should be as nearly perpendicular as possible (fig. 7) to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

POWER REQUIRED

The power necessary to operate the cutter depends upon width of cutter throat, sharpness of knives, type of elevator, height of silo, rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed below full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. The figures in Table 3 represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. This table has been prepared from manufacturers' statements, personal observations, and experience, and is not the result of actual experimental tests.

TABLE 3.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying widths of cutter throat and varying heights of silos*

Width of cutter throat	Height of silo—feet														Approximate capacity
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower														
															Tons per hour
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

If a steam engine is used the horsepower ratings may be 25 per cent less than the above figures. If an electric motor is used the rated horsepower can be 15 per cent less than the figures in the table.

PACKING THE SILAGE

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being flexible (fig. 8) can be swung so as to place the material anywhere in the silo. With this contrivance it is not necessary to handle

the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some object which might be blown up the blower pipe. As the silage rises in the silo the distributer pipe, which is put together in sections, can be readily shortened.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

FIG. 8.—Jointed-pipe silage distributer

ADDING WATER

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will become fire-fanged and will deteriorate through the growth of mold. Enough water should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied by means of a hose and spray nozzle, directly on the silage in the silo as it is filled; or be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at longer intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

RONNING METHOD OF MAKING SILAGE

The Ronning method of silo filling has been used to some extent in the last few years. The standing corn is harvested and cut into proper lengths for the silo at one operation, by a combined harvester and cutter. The cut corn is delivered to a wagon box drawn alongside. This is then hauled to the silo and pushed off into a blower which elevates it into the silo.

COVERING THE SILAGE

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to keep the air out of the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled. If this is done, no covering is necessary and there should be no loss on account of spoiling.

FEEDING VALUE OF SILAGE

COMPOSITION

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. (See Table 4.)

PALATABILITY

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the Corn Belt often refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

TABLE 4.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds*

(From "Feeds and Feeding," by Henry and Morrison)

Crop	Total dry matter	Digestible dry matter			True protein	Net energy value
		Crude protein	Carbohydrates	Fat		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Therms*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.60
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder	24.9	.7	14.8	.7	.4	15.37
Sorghum silage	22.8	.6	11.6	.5		
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	24.4	2.0	9.6	.8	.8	7.25
Uncured soybeans	23.6	3.2	10.2	.5	2.4	12.53
Soybean silage	27.2	2.8	10.8	.9	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	21.2	1.8	9.7	.5	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6		
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	9.3	.5	6.5	.2	.5	8.99
Prickly pear	16.5	.4	8.9	.2		
Sunflower silage	21.9	1.0	9.8	.8		

SILAGE FOR DAIRY CATTLE

By T. E. Woodward and J. B. McNulty, *Bureau of Dairying*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous on farms devoted to dairying than on any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for winter feed.

SUPPLEMENTARY FEEDS

While corn silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. However, a ration of corn silage and legume hay without grain is satisfactory only for cows which are dry or which give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED

A cow should be fed as much silage as she will clean up without waste when fed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller cows eat from 20 to 30 pounds a day, and the larger as much as 40 or more.

RATIONS

In general, dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day, or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in the proportion of about 2.5 to 3 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 3 or 4 pounds of milk produced, in addition to roughage, is fed. For Jerseys 1 pound for each 2.5 to 3 pounds of milk will come nearer to meeting the requirements. The grain for other breeds varies between these two according to the richness of milk produced. A rule used to some extent is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of first-class legume hay little grain is needed for cows of ordinary production. Alfalfa especially, if fed liberally, will enable the feeder to reduce the grain allowance to the minimum.

TIME TO FEED

Although good corn silage has no pronounced effect on the flavor and odor of milk, it is probably best to feed it either just after

milking or several hours before milking, to avoid tainting the milk.[8] Silage is usually fed twice a day.

RATE OF FEEDING

Silage spoils readily when exposed to air or heat. When feeding a uniform layer from the whole surface of the exposed silage should be removed. This layer should be not less than 3 inches thick in summer. It is important that the diameter of a silo for summer use be such that a depth of at least 3 inches of silage can be fed out daily. This is in order that the silage for each day's feed will be as fresh as possible.

If less than a 3-inch layer is taken out daily, some at the top may spoil before the next day.

In cold weather it may be removed slowly as desired, since spoiling does not take place so readily. Silage in a silo from which some had been fed out have been known to keep in perfect condition, except for some drying on the surface, for a month or longer in winter.

As a means of preventing loss from surface spoilage the Missouri Agricultural Experiment Station uses and recommends a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls upon a circular iron frame. By means of a pulley and rope the canvas can be raised or lowered.

FEEDING FROZEN SILAGE

Frozen silage must be thawed before using, after which it should be fed immediately, before decomposition sets in. No harm will result from feeding such silage, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume about half as much as mature stock, that is, from 16 to 26 pounds a day if they are well grown. When supplemented with some good leguminous hay, little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds a day for each 1,000 pounds of live weight. When fed in this quantity, silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Dry cows consume almost as much roughage as when they are at the pail. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 40 pounds of silage and a small sup-

[8] See Department Bulletin 1097, "Effect of Silage on the Flavor and Odor of Milk."

plementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. How much to feed depends on the condition of the pastures, the quantity varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES AND MULES

By GEORGE M. ROMMEL, *formerly Chief of the Animal Husbandry Division, Bureau of Animal Industry*

(Revised by J. O. Williams, of the Animal Husbandry Division)

Silage is not generally used in horse and mule feeding, but it is a safe feed for either horses or mules if it is of good quality and is carefully fed.

Both horses and mules are peculiarly susceptible to the effects of molds, and under certain conditions varieties of molds are found in silage which are deadly poisons to both of these classes of stock. Such molds are the result of either the improper cutting or packing of the silage, or both. Molds must have air to grow. Silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warm, he can soon detect the presence of mold. When mold appears, the feeding should be stopped immediately. Similarly, care should be exercised in the winter feeding of silage so that horses or mules are not allowed to eat frozen silage, because of the danger of colic.

Corn silage is the only kind that so far has met with any degree of favor as a horse or mule feed. Corn which is to be ensiled for this purpose should not be cut too green, as sour silage will result, and this may cause colic when fed. Corn for such feed, rather, should be cut when it has begun to glaze, and the silo, once the ensiling process has been started, should be filled as rapidly as possible. When filling the silo it is essential that the corn be carefully and thoroughly tramped and packed. This is one of the most important points in the feeding of silage to horses and mules. Cutting the silage fine and in lengths of less than 1 inch will facilitate packing. If tramping and packing are properly done, no feeding danger is likely to result, but if these operations are slighted, air pockets may

form and cause the accumulation of small masses of mold. Such mold, if overlooked in feeding, may be sufficient to kill one or more of the animals fed.

Silage should not be considered as the principal roughage for horses and mules, but should serve as a partial substitute for hay in the daily ration. Because of its bulky nature, horses and mules doing hard work should not be fed large quantities, but, due to its tonic, laxative, and appetizing effects, it is well suited for the maintenance of idle horses and mules, brood mares, and growing stock. The value of silage is greatest, in the case of horses and mules, as a means to carry them through the winter cheaply or to supplement pasture during periods of drought. When used, silage should be introduced gradually into the ration, and the amount fed should generally not exceed 10 to 15 pounds daily per animal.

SILAGE FOR BEEF CATTLE

By E. W. SHEETS, *Chief of the Animal Husbandry Division, Bureau of Animal Industry*

No roughage occupies a more important place in the economical feeding of beef cattle than silage. The increased value of all roughages as well as of grain has correspondingly increased the value of silage in its various forms for beef production. While silage is not a cheap feed, it is in most cases a great saver of grain as well as of other feeds, whether fed to breeding stock, growing animals, or fattening cattle.

SILAGE FOR THE BREEDING HERD

Silage, when available, should form the principal part of the winter ration for the breeding herd. (Fig. 9.) Cows and calves relish it and thrive upon it when some supplement is added. Silage in the ration creates an appetite for less palatable and cheaper roughages, thus reducing the cost of wintering. As a rule, good legume hays should be fed to the cows suckling calves, unless a protein concentrate such as cottonseed meal or linseed meal is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain the weight of the cattle

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc.)	6 to 8			
Nonlegume hay (grass hays, also stover)		6 to 8		
Cereal straw (oat, wheat, rye, etc)	2 to 4	2 to 4	8 to 10	
Protein concentrate (linseed meal, cottonseed meal, etc.)		½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughage, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the

cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be determined largely by the quality of the silage. If there is little mature corn in the silage, or if the mature corn was removed before filling the silo, it is necessary to give more silage or to supplement it with other or more nutritious feeds.

Generally good results are obtained in feeding breeding bulls half as much silage as is given to cows. As in the ration for breeding cows a small amount of grain should be supplied in addition to the silage, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES

Calves should be fed silage only in limited quantities before they are weaned. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little

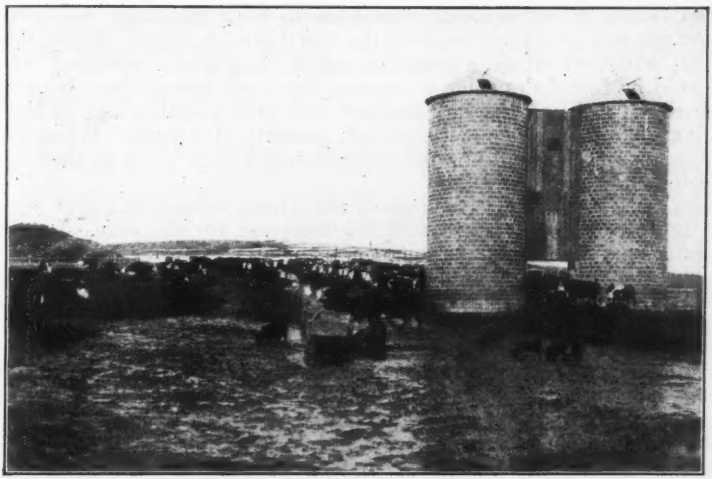

FIG. 9.—Silage is one of the best roughages for wintering the beef breeding herd

weight during the weaning period when they are liberally fed on grain, legume hay, and silage. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay. A calf will eat the coarser, cheaper roughages, but as a rule will give greater returns than older cattle from the use of better feeds and dry roughages, such as clover, alfalfa, and lespedeza.

A small quantity of grain should also be given for best results, together with a very little linseed meal, peanut meal, or cottonseed meal.

TABLE 6.—*The following rations will keep a calf weighing from 400 to 600 pounds in a thrifty, growing condition and allow considerable gain during the winter*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	15 to 20	15 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5			
Nonlegume hay (grass hays, also stover)		4 to 6		
Cereal straw (oat, wheat, etc.)			4 to 6	
Protein concentrates (linseed meal, cottonseed meal, etc.)		¼ to ½	½ to 1	¾ to 1½

SILAGE FOR WINTERING STOCKERS

While silage is undoubtedly one of the best feeds for wintering stockers or feeders of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do breeding cows or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Many, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better advantage than other cattle except, possibly, dry cows. When such silage is used it should be fed more liberally than when no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is desirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price and grain is comparatively cheap, it may be advisable to limit the dry roughage to a few pounds and greatly increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, linseed meal, or velvet beans.

TABLE 7.—*The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4			
Nonlegume hay (grass hays, also stover)		3 to 4		
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	
Protein concentrate (cottonseed meal, linseed meal, etc.)		½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are especially adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of

silage fed. The dry roughages should also be increased accordingly from 3 to 5 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE

The use of silage in rations for fattening cattle varies considerably throughout the steer-killing sections and is governed primarily by other kinds of roughage grown within the areas. In those localities where alfalfa and clover hay are produced abundantly, the use of silage for fattening beef cattle is rather limited, whereas in other areas producing grass hays or mixed hay largely silage is more extensively used. Ordinarily an abundance of cheap, dry roughage lessens the use of silage. The market value of grain also is a determining factor affecting the use of silage. When corn and other grains are high priced, their use in the ration is usually limited and the quantity of silage and protein concentrates is increased.

Experiments have shown that a certain amount of dry roughage should be fed in silage rations. Silage rations usually necessitate a longer feeding period.

TABLE 8.—*For 1,000-pound fattening animals the following average rations should be found satisfactory*

Feeds fed	Average daily amount of feed [1]				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8			1½ to 2
Nonlegume hay (grass hay, also stover)			4 to 6	6 to 8	
Protein concentrate,[2] (cottonseed meal, linseed meal, etc.)	2 to 3		3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10		

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found approximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts stated but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP

By F. R. MARSHALL, *Collaborator in Sheep Investigations, Animal Husbandry Division, Bureau of Animal Industry*

(Revised by D. A. Spencer, of the Animal Husbandry Division)

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. It has been proved by different experiment stations in tests with both

breeding and feeder lambs that good silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of good-quality silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be in the ration.

Silage shows the best results when fed with a good legume hay. The following has been found to be a good ration for the breeding ewe:

	Pounds
Corn silage	3 to 4
Clover or alfalfa hay	2 to 3

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration. thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable, in the latitude of the Corn Belt and the South.

SILAGE FOR LAMBS

In fattening lambs, corn silage not only saves hay and grain but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this, offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.12

In wintering ewe lambs, silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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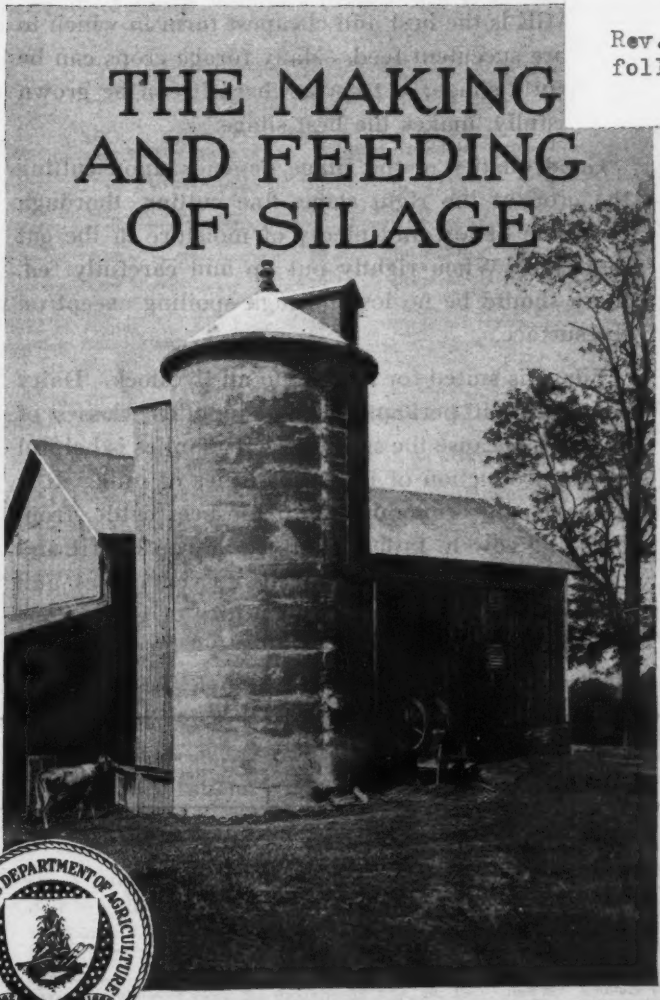
THE MAKING AND FEEDING OF SILAGE



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage; but corn, where it can be grown successfully, makes the best silage.

Good quality in the silage depends upon cutting the crop at the right stage, fine cutting, thorough exclusion of air, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be no loss through spoiling except on the surface.

Silage is suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is helpful in the production of large quantities of milk. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

Washington, D. C.

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THE MAKING AND FEEDING OF SILAGE

By T. E. WOODWARD, *Senior Dairy Husbandman*, and J. B. MCNULTY, *Dairy Husbandman, Bureau of Dairy Industry;* and GEORGE M. ROMMEL, E. W. SHEETS, *Chief Animal Husbandry Division;* and F. R. MARSHALL, *Collaborator, Bureau of Animal Industry*[1]

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MANUFACTURE AND FEEDING VALUE OF SILAGE

By T. E. WOODWARD and J. B. MCNULTY

SILAGE is feed that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition.

Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Livestock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, more healthy appearance than those fed exclusively on dry rations.

LOSSES OF FOOD NUTRIENTS IN THE SILO

When a crop is placed in the silo the temperature of the material rises in a few days to about blood heat and then gradually diminishes. The sugars are converted to acids, mainly lactic and acetic, which give the silage a sour taste and help to preserve it by inhibiting the

[1] Mr. McNulty resigned from the department Aug. 26, 1919, and Mr. Rommel Oct. 31, 1921.

growth of certain organisms. Normal corn silage contains about 1.5 per cent of acid.

Losses of food nutrients are due to two causes—contact with air and fermentation. The air may be excluded from the silo by proper packing of the material, by air-tight construction, and by careful attention to sealing cracks around the doors. The top of the silage is necessarily exposed to the air and will spoil, but this is the only spoiling due to air which can not be avoided. In a silo 14 feet in diameter the amount of spoiled silage on the top will be 1½ or 2 tons three months after filling.

Losses due to fermentation can not be avoided. According to the Missouri Agricultural Experiment Station [2] these losses of dry matter for various crops are as follows: Corn, 4.01 per cent; grass crops, 18.06 per cent; peas and oats, 6.90 per cent; and legume crops, 2.12 per cent.

CROPS SUITABLE FOR SILAGE

By the exercise of proper methods almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, legumes for example, are deficient in the fermentable constitutents so desirable in the production of silage that is palatable and possesses good keeping qualities. On the other hand, a few crops, such as the sorgos, have so much sugar that unless cut at a more mature stage they have a tendency to produce a silage that is too sour.

CORN

Corn is the common silage crop wherever it can be grown successfully. (Fig. 1.) Silage made from corn has a good flavor, is very palatable, and will keep in good condition for years. It contains nearly as high a percentage of digestible nutrients as the corn from which it was made. When it is properly siloed, the losses of digestible nutrients from fermentation are smaller than in most other crops.

Over a considerable portion of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, loses 4.01 per cent of the dry matter against 15.12 per cent when cut for fodder and cured in the field.[3] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is practically all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite of the many strong points in favor of corn as a silage crop, however, it is not a perfect ration, because it is low in both pro-

[2] RAGSDALE, A. C., and TURNER, C. W. SILAGE INVESTIGATIONS—LOSS OF NUTRIENTS IN THE SILO AND DURING THE FIELD CURING OF CORN. Missouri Agr. Expt. Sta. Research Bul. 65, 10 p. 1924.

[3] RAGSDALE, A. C., and TURNER, C. W. Op. cit.

tein and mineral matter. In filling the silo, clover, cowpeas, soy beans, or alfalfa is sometimes mixed with corn in order to correct the deficiency of protein. Ordinarily this is not to be advised if the legumes can be made into a good quality of hay.

VARIETIES TO PLANT

As there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. Since the corn does not need to be so mature for silage as for grain, it is possible to use a later maturing variety and thus obtain a greater yield than would be obtained from the varieties ordinarily planted for grain. At the Ohio experiment station it was found [4] that early maturing corn yielded 10.31 tons

FIG. 1.—Well-eared corn makes silage of the best quality

of silage per acre whereas late maturing corn yielded 11.97 tons. There appears to be little if any advantage in using a variety which produces foliage and stalk at the expense of grain as the ears contain the most valuable part of the food constituents. Ordinarily the variety of corn which produces the most grain to the acre is the best to use for silage. The greater the quantity of grain in the silage the more nutritious the silage and the greater the saving of concentrated feed used to supplement the silage.

METHODS OF PLANTING

Work at the Illinois experiment station [5] shows that thick planting results in greater tonnage and in more stalk and foliage in propor-

[4] HAYDEN, C. C. "SILAGE CORN" OR "FIELD CORN" FOR SILAGE? Ohio Agr. Expt. Sta. Mo. Bul. 8: 145–148. 1923.

[5] MORROW, G. E., and HUNT, T. F. FIELD EXPERIMENTS WITH CORN, 1890. Ill. Agr. Expt. Sta. Bul. 13: [389]–432, illus. 1891.

tion to the ears than does thin planting. When the corn is planted less than about 12 inches apart in rows 40 to 44 inches apart on good land, the total yield of ears is decreased and the proportion of poor ears to good ears is increased. Planting more than about 12 inches apart on good land increases the proportion of good to poor ears but decreases the total weight of ears. It is thought best to space the planting so as to obtain the greatest total yield of ears. On good land this will be about 12 inches; on poorer land possibly as much as 18 inches. On weedy land it is better to plant in hills so that the corn can be cultivated both ways, in which case the planting may vary from two or three kernels in a hill to three or four kernels, depending upon the fertility of the soil. The growth of weeds lowers the yield of corn, but unless weeds are present in great numbers they do not noticeably affect the quality of the silage and therefore can be cut along with the corn and put into the silo.

YIELD

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed. The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 or 5½ bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking—that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 to 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 1 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station)[6] shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, when a large quantity of silage is made and weather conditions are favorable the moisture content can not be kept within these limits.

[6] LADD, E. F. REPORT OF THE CHEMIST. N. Y. State Agr. Expt. Sta. Ann. Rpt. (1889) 8: [71]–214. 1890.

TABLE 1.—*Chemical changes during growth of corn plant*

Yield per acre	Stage of growth				
	Tasseled, July 30	Silked, Aug. 9	Milk, Aug. 21	Glazed, Sept. 7	Ripe, Sept. 23
Total yield	*Pounds* 18,045.00	*Pounds* 25,745.00	*Pounds* 32,600.00	*Pounds* 32,295.00	*Pounds* 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	20,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix such corn with some which is more mature. Silage from immature corn will be more sour than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible, in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without the addition of water. The frosting of the corn causes only a small decrease in feeding value, the greater part being due to the loss of leaves in handling.

DRY CORN FODDER

Sometimes there is a delay in filling the silo and it is necessary to cut and shock the corn; also, on farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out. Dry corn fodder may be siloed successfully, but it is absolutely necessary that water enough be added to make it pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower or the top of the blower pipe while filling. In addition, it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. It also lacks the aroma of good corn silage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[7] Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

[7] ECKLES, C. H. SHOCK CORN FOR SILAGE. Missouri Agr. Expt. Sta. Circ. 71, p. 25–28, illus. 1914.

Corn stover likewise can be made into silage by the same method. It lacks flavor and palatability and is low in feeding value. It is doubtful whether the making of such silage is an economical practice.

SORGHUMS

The sorgos (saccharine sorghums), such as Amber cane and Orange cane, and nonsaccharine sorghums, such as Kafir, feterita, milo, Japanese cane, Napier grass, and Sudan grass, are all suitable for silage. Sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular or the soil too poor for a good growth of corn. For successful silage it is important that the saccharine sorghums be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas[8] and California[9] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

FIG. 2.—Shock corn, if properly handled, will make fair silage

LEGUMES

The legumes include the clovers, alfalfa, cowpeas, soy beans, velvet beans, and vetches. All of these may be made into a good quality of silage under proper conditions. It is ordinarily a better practice, however, to make them into hay provided weather conditions permit proper curing. A crop can be preserved more cheaply as hay than as silage because of the lesser weight of water which must be handled and because of the lack of

[8] REED, O. E., and FITCH, J. B. SORGHUM CROPS FOR SILAGE. FEEDING EXPERIMENTS WITH DAIRY CATTLE. Kans. Agr. Expt. Sta. Circ. 28, 6 p. [1913.]

[9] WOLL, F. W., and VOORHIES, E. C. TRIALS WITH CALIFORNIA SILAGE CROPS FOR DAIRY COWS. Calif. Agr. Expt. Sta. Bul. 282, p. [19]–40. 1917.

machinery adapted to the easy handling of broadcast crops in the green state. It is possible also that properly cured hay contains valuable vitamins that would be destroyed if the crop were put in the silo.

Legumes have a low content of sugar from which the acids so helpful in the preservation of silage are developed. For this reason greater precautions must be exercised in the making of legume silage than are necessary with the nonleguminous crops. All the legumes may be siloed successfully if mixed with a crop containing much sugar, such as corn or the sorghums; or they may be siloed alone provided the moisture content of the material is sufficiently low. When all conditions are favorable the resulting silage is palatable and the losses of food nutrients probably no greater than with corn.

At the Kansas experiment station [10] alfalfa was made into silage successfully by the addition of blackstrap molasses at the rate of 4 or 5 per cent by weight. The molasses was said to improve both the palatability and the keeping quality of the silage. At the Missouri experiment station [11] alfalfa made good silage when the moisture content of the crop ranged between 50 and 70 per cent as a result of either allowing the crop to mature sufficiently or partially drying it in the field for a few hours after mowing. On the other hand a greater moisture content resulted in ill-smelling, unpalatable silage and a considerable loss of food nutrients. Except during a period of low rainfall alfalfa at the haymaking stage usually contains too much moisture to make good silage.

The Missouri station also reports that the clovers, soy beans, and cowpeas may be made into good silage provided the moisture content is not too high. Clover for silage should be allowed to become somewhat more mature than when cut for hay. Soy beans and cowpeas should reach the stage when the seeds are well developed and the pods are beginning to turn yellow. If they have not reached this stage they should be allowed to lie in the field until thoroughly wilted.

While cowpeas and soy beans may be siloed separately, a more general practice is to use them in combination with corn or sorghum. They are grown either in separate fields or with the corn. When grown with corn cowpeas climb the stalks and make harvesting difficult. Soy beans, being self-supporting, can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soy beans make a more satisfactory crop to grow with the corn.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important

[10] REED, O. E. LATE SILAGE INVESTIGATIONS. Hoard's Dairyman 53: 322, 350, illus. 1917.

[11] ECKLES, C. H. LEGUMES, SUDAN GRASS, AND CEREAL CROPS FOR SILAGE. Missouri Agr. Expt. Sta. Bul. 162. 25 p. 1919.

to cut them fine and pack them firmly in the silo. The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

Of these crops rye especially makes a rather unpalatable silage which must be fed with care to avoid tainting the milk.

FIELD PEAS AND OATS, OR VETCH AND WHEAT

Field peas and oats or vetch and wheat planted together make a palatable silage high in protein and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut oats and peas for silage is when the oats are in the late dough stage or showing first signs of turning yellow and the pea pods are turning slightly yellow. At this time the crop contains 30 to 40 per cent of moisture, which is the essential condition to success. If cut earlier the crop should be allowed to dry to some extent before it is placed in the silo. Probably wheat and vetch should be harvested at a similar stage of maturity. Fine cutting and thorough packing are necessary when peas and oats or wheat and vetch are siloed together.

MILLET

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are probably more profitable when used as soiling crops or as hays.

PEA VINES

Pea vines from canning factories are used for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be used until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it

damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches of depth increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to keep out the air. Other coarse roughage, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

CANE TOPS AND CANE BAGASSE

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they

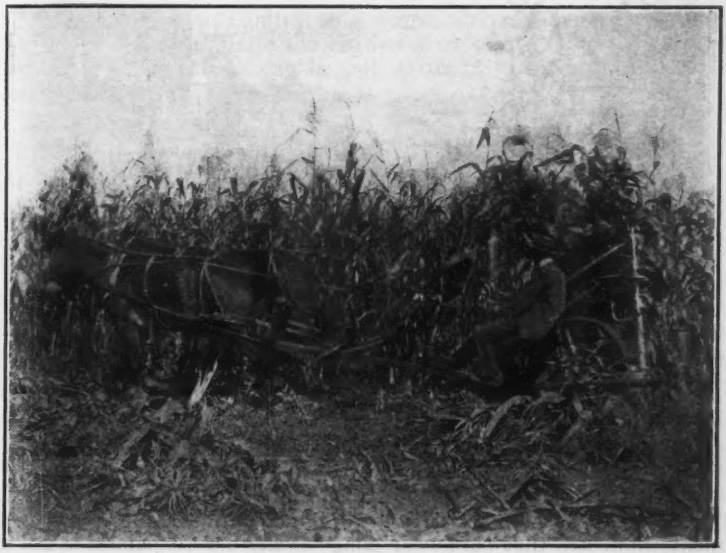

FIG. 3.—A corn harvester at work

are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS

Sunflowers are used to some extent in the West and Northwest, where the weather is too cold and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn in some localities. As high as 29.75 tons to the acre has been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther

apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

Opinions differ as to the feeding value of sunflower silage. In some experiments it seems to be practically equal to corn silage; in others it is inferior. Doubtless the stage of maturity at harvesting time of both the sunflowers and the corn has been partly responsible for this lack of uniformity in results. A composite of all experi-

FIG. 4.—The platform cutter is adapted for use where only a small quantity of silage is to be made

ments indicates that sunflower silage is neither so palatable nor so valuable, pound for pound, as corn silage, though it may be fully equal to some of the other kinds of silage.

MISCELLANEOUS CROPS

Beet pulp, apple pomace, Russian thistle, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO

Corn or sorghums for the silo may be cut by hand, by the one-horse, two-row platform cutter (fig. 4), or by the corn harvester and binder. Hand cutting is practiced on farms where the quantity to be cut is too small to justify the purchase of a harvester and when the corn is down or in such position as to preclude the successful use of

the platform cutter or the corn harvester. Of the three methods the Nebraska experiment station [12] found that although the cost per acre of cutting corn was the lowest when the platform cutter was used, all things considered the corn harvester constituted the most satisfactory method. In case only a small quantity is to be harvested on each farm, several farmers might well cooperate in the purchase of a harvester rather than to do the work by hand.

In using the corn harvester the bundles should be made rather small. While this takes more twine, the extra expense is more than offset by the ease of handling the bundles and feeding them into the silage cutter. The harvester should not get so far ahead of the haulers that the corn will lose any considerable amount of moisture before it reaches the cutter.

A bundle elevator which is attached to the corn harvester in place of the bundle carrier has come into use in the last few years. This elevator delivers the bundles to a wagon driven alongside the harvester. Its use eliminates the hardest part of the silo-filling operation. A load of 2 tons can be put on in 12 to 15 minutes. When

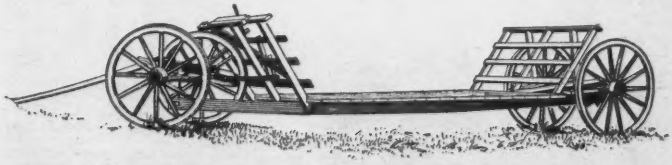

FIG. 5.—A low rack for hauling corn to cutter

the elevator is used the power necessary to pull the harvester is increased, and this fact, together with the need for a steady power, makes the use of a tractor desirable.

HAULING TO THE CUTTER

Ordinarily the corn is hauled to the cutter on a common, flat hayrack. It is best to have this rack mounted on a low-wheeled wagon, even when used in connection with a harvester and elevator. Of course, when the loading is done by hand a low-wheeled wagon is preferable to a high-wheeled one. (Figs. 5 and 6.)

A low rack or body can be made easily. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, Cost of Filling Silos: [13]

> The rack . . . consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. . . . The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

[12] CHASE, L. W., and WOOD, I. D. HANDLING SILAGE. Nebr. Agr. Expt. Sta. Bul. 145, 25 p., illus. 1914.

[13] CARRIER, L. COST OF FILLING SILOS. U. S. Dept. Agr. Farmers' Bul. 292, 15 p., illus. 1907.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading and facilitating the work of unloading.

CUTTING THE SILAGE

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are whether or not it is strongly made and will cut fine. The capacity is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that everyone will be able to keep busy

FIG. 6.—Loading corn on the wagon, the hardest work of all

all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes often lack. Other factors to be taken into account are the amount of work to be done and the power to be used.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand, the longer the pieces the more rapidly the corn can be run through the cutter. Probably most silage is now cut into pieces about half an inch long.

ELEVATING THE SILAGE

Two types of elevators are in use, the old-style chain carrier and the blower. The chain carrier requires less power but is harder to set up and is not so well adapted for high silos. Some chain carriers are inclosed so as to keep the corn from blowing out. In using the blower type the blower should be as nearly perpendicular as possible (fig. 7) to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

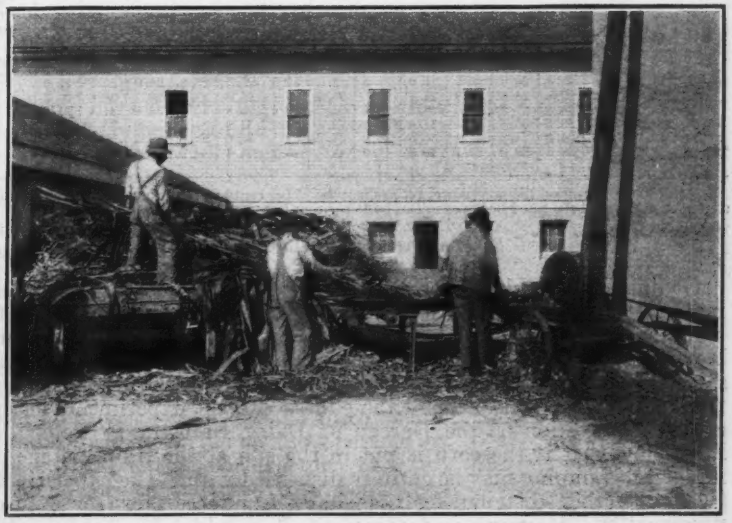

FIG. 7.—Silage cutter with blower

POWER REQUIRED

The power necessary to operate the cutter depends upon width of cutter throat, sharpness of knives, type of elevator, height of silo, rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed below full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. The figures in Table 2 represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. This table has been prepared from manufacturers' statements, personal observations, and experience, and is not the result of actual experimental tests.

TABLE 2.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying widths of cutter throat and varying heights of silos*

Width of cutter throat	Height of silo—feet													Approximate capacity
	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	Horsepower													
														Tons per hour
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	4
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	5
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	7
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	19
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	11
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	13
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	15
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	17
															9

If a steam engine is used the horsepower ratings may be 25 per cent less than the above figures. If an electric motor is used the rated horsepower can be 15 per cent less than the figures in the table.

PACKING THE SILAGE

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless the material is distributed the leaves are blown to one side of the silo. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. Recent experiments at the experiment station of the Bureau of Dairy Industry at Beltsville, Md., show that if the corn is put in the silo at the proper stage of maturity, tramping may be entirely dispensed with. The experiments show also that distributing the silage is unnecessary for perfect preservation. However, in feeding out silage which has not been distributed, it is desirable to take a layer off the entire top of the silage at each feeding, otherwise there is likelihood of getting a batch of silage which contains a preponderance of either leaves or the heavier constituents of the corn plant.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being flexible (fig. 8) can be swung so as to place the material anywhere in the silo. With this contrivance it is not necessary to handle the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some object which might be blown up the blower pipe. As the silage rises in the silo the distributor pipe, which is put together in sections, can be readily shortened.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless the silage is well packed, air will enter and mold will develop. Enough water should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied by means of a hose and spray nozzle, directly on the silage in the silo as it is filled; or it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full and has been leveled off. This helps to pack the top layer and to lessen the spoilage.

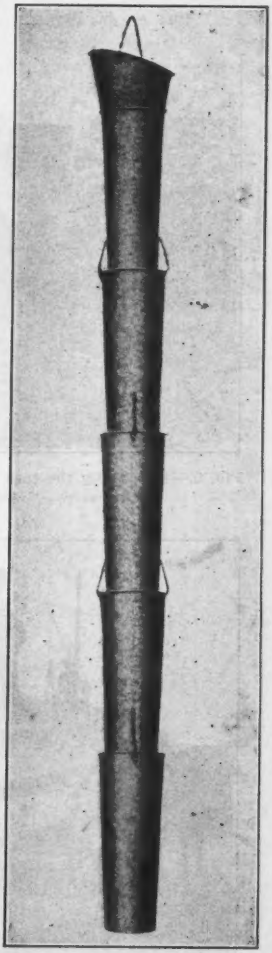

FIG. 8.—Jointed-pipe silage distributor

RONNING METHOD OF MAKING SILAGE

The Ronning method of silo filling has been used to some extent in the last few years. The standing corn is harvested and cut into proper lengths for the silo by a machine drawn by a tractor and operated by means of power from the tractor. (Fig. 9.) The cut corn is delivered to a wagon box drawn alongside. It is then hauled to the silo and pushed off into a blower which elevates it into the silo. (Fig. 10.) With a pit silo the material can be dumped directly into the silo. This method of making silage is the easiest known. It is about as rapid and requires approximately the same size crew as when a harvester and bundle elevator are used. It is easier, however, because the labor of placing the bundles in the wagon is saved and because pushing the cut material into the blower is easier than throwing the corn bundles into the cutter. It is probable also that the Ronning outfit will operate successfully on softer ground than will the harvester and elevator on account of the mechanism being operated by power from the tractor. A disadvantage of the Ronning system is that the corn may be blown down so that hand cutting must be resorted to, in which case the ordinary kind of silage cutter must be used.

COVERING THE SILAGE

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer

FIG. 9.—Harvesting the corn by the Ronning method. (Courtesy of Central Experiment Farm, Ottawa, Canada)

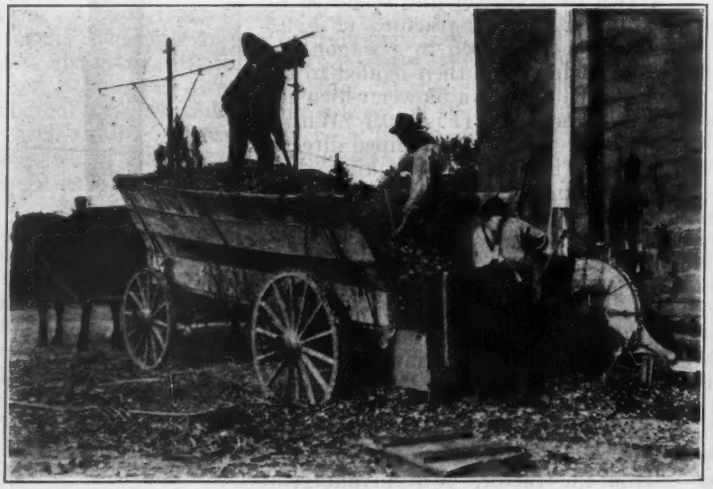

FIG. 10.—Transferring the cut corn to the silo by the Ronning method. (Courtesy of Central Experiment Farm, Ottawa, Canada)

from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack

much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to keep the air out of the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled. If this is done, no covering is necessary and there should be no loss on account of spoiling.

FEEDING VALUE OF SILAGE

COMPOSITION

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. (Table 3.)

TABLE 3.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds*

(From Feeds and Feeding, by Henry and Morrison) [1]

Crop	Total dry matter	Digestible dry matter			True protein	Net energy value
		Crude protein	Carbohydrates	Fat		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Therms*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.60
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder	24.9	.7	14.8	.7	.4	15.37
Sorghum silage	22.8	.6	11.6	.5		
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	24.4	2.0	9.6	.8	.8	7.26
Uncured soybeans	23.6	3.2	10.2	.5	2.4	12.53
Soy-bean silage	27.2	2.8	10.8	.9	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	21.2	1.8	9.7	.5	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6		
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	9.3	.5	6.5	.2	.5	8.99
Prickly pear	16.5	.4	8.9	.2		
Sunflower silage	21.9	1.0	9.8	.8		

[1] HENRY, W. A., and MORRISON, F. B. FEEDS AND FEEDING. Ed. 18, unabridged, 770 p., illus. Madison, Wis. 1923.

PALATABILITY

Palatability is of much importance because it induces a large consumption and because it stimulates the secretion of digestive juices. No rough feed is more palatable than good corn silage. Cows nearly always eat silage in preference to hay. If any of the ration is refused it is more often the hay than the silage.

SILAGE FOR DAIRY CATTLE

By T. E. WOODWARD and J. B. MCNULTY

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous on farms devoted to dairying than on any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for winter feed.

SUPPLEMENTARY FEEDS

Although corn silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be fed along with some leguminous hay, such as clover, soy beans, or alfalfa. These supply the deficiencies of silage in protein and mineral constituents. However, a ration of silage and hay alone is still too bulky to be satisfactory for other than dry cows or those giving a small quantity of milk. Cows can not consume enough of these two feeds to support a liberal flow of milk and maintain their body weight. They must have some concentrated feed.

RATIONS

A good rule to follow in the feeding of silage is to allow each cow about 3 pounds of silage a day for each 100 pounds of live weight. For example, give an 800-pound cow 24 pounds of silage, a 1,200-pound cow 36 pounds of silage, and so on. Along with this give the cow all the hay that she will eat. The quantity of grain to feed depends upon a number of factors, chief of which are quantity and quality of milk yield and kind and quality of hay fed. The quantity of silage stated above and all the good legume hay the cow will eat twice a day will support a milk yield of 10 to 16 pounds, depending upon the richness of the milk. Consequently a cow giving these quantities requires no grain. For the production of milk above these quantities the nutrients must be provided in the grain. About 0.4 pound of grain is required to provide the nutrients for the production of 1 pound of milk testing 3.5 per cent or less butterfat, 0.5 pound for milk of medium richness testing 4 to 4.5 per cent, and about 0.6 pound for milk testing more than 5 per cent. For example, if a cow is giving 25 pounds of milk testing more than 5 per cent, 10 pounds of this will be provided for by the roughage, whereas 15 pounds must be provided for by the grain. The quantity of grain needed, therefore, is 15×0.6 pound, or 9 pounds. If a cow is giving 36 pounds of milk testing 3.5 per cent or less, 20 pounds must be provided for by the grain. The quantity of grain needed for this cow, therefore, is 20×0.4 pound, or 8 pounds. Coarse or poorly cured legume hay or grass hay is not consumed in such great quantities as good legume hay. Consequently when such hay is fed the grain allowance must be increased.

TIME TO FEED

Although good corn silage has no pronounced effect on the flavor and odor of milk, it is probably best to feed it either just after milking or several hours before milking, to avoid tainting the milk.[14] Silage is usually fed twice a day.

RATE OF FEEDING

When silage is exposed to the air in warm weather it spoils quickly. For this reason a uniform layer should be removed from the top every

[14] GAMBLE, J. A., and KELLY, E. THE EFFECT OF SILAGE ON THE FLAVOR AND ODOR OF MILK. U. S. Dept. Agr. Bul. 1097, 24 p., illus. 1922.

day. In summer this layer should be not less than 3 inches thick but during cold weather feeding may be as slow as desired. Except for some drying on the surface, silage from which the top had been fed has been known to keep in perfect condition for a month or longer in winter.

As a means of preventing loss from surface spoilage the Missouri Agricultural Experiment Station uses and recommends a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls upon a circular iron frame. By means of a pulley and rope the canvas can be raised or lowered.

FEEDING FROZEN SILAGE

Frozen silage must be thawed before using, after which it should be fed immediately, before decomposition sets in. No harm will result from feeding such silage, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS

Although silage has been fed successfully to vigorous young calves as soon as they would eat it and in as large quantities as they would consume, there is some evidence that it should be omitted from the ration until the danger of serious digestive disturbance is past, say 60 days, after which it may be fed safely in quantities up to the capacity of the calf. Yearling heifers consume about half as much as mature stock, that is, from 12 to 24 pounds a day if they are well grown. When supplemented with some good leguminous hay, little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds a day for each 1,000 pounds of live weight. When fed in this quantity, silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

When cows are dry they consume almost as much roughage as when they are producing milk. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 40 pounds of silage and from 5 to 8 pounds a day of clover, soy bean, or alfalfa hay—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive some grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed. Later in the fall it is impossible to restore the

milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. How much to feed depends on the condition of the pastures, the quantity varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES AND MULES.

By GEORGE M. ROMMEL (Revised by J. O. Williams, of the Animal Husbandry Division)

Silage is not generally used in horse and mule feeding, but it is a safe feed for either horses or mules if it is of good quality and is carefully fed.

Both horses and mules are peculiarly susceptible to the effects of molds, and under certain conditions varieties of molds are found in silage which are deadly poisons to both of these classes of stock. Such molds are the result of either the improper cutting or packing of the silage, or both. Molds must have air to grow. Silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warm, he can soon detect the presence of mold. When mold appears, the feeding should be stopped immediately. Similarly, care should be exercised in the winter feeding of silage so that horses or mules are not allowed to eat frozen silage, because of the danger of colic.

Corn silage is the only kind that so far has met with any degree of favor as a horse or mule feed. Corn which is to be ensiled for this purpose should not be cut too green, as sour silage will result, and this may cause colic when fed. Corn for such feed, rather, should be cut when it has begun to glaze, and the silo, once the ensiling process has been started, should be filled as rapidly as possible. When filling the silo it is essential that the corn be carefully and thoroughly tramped and packed. This is one of the most important points in the feeding of silage to horses and mules. Cutting the silage fine and in lengths of less than 1 inch will facilitate packing. If tramping and packing are properly done, no feeding danger is likely to result, but if these operations are slighted, air pockets may form and cause the accumulation of small masses of mold. Such mold, if overlooked in feeding, may be sufficient to kill one or more of the animals fed.

Silage should not be considered as the principal roughage for horses and mules, but should serve as a partial substitute for hay in the daily ration. Because of its bulky nature, horses and mules doing hard work should not be fed large quantities, but, due to its tonic, laxative, and appetizing effects, it is well suited for the maintenance of idle horses and mules, brood mares, and growing stock. The value of silage is greatest, in the case of horses and mules, as a means to carry them through the winter cheaply or to supplement pasture during periods of drought. When used, silage should be introduced gradually into the ration, and the amount fed should generally not exceed 10 to 15 pounds daily per animal.

SILAGE FOR BEEF CATTLE

By E. W. Sheets

SILAGE FOR THE BREEDING HERD

Silage, when available, should form the principal part of the winter ration for the breeding herd. (Fig. 11.) Cows and calves relish it and thrive upon it when some supplement is added. Silage in the ration creates an appetite for less palatable and cheaper roughages, thus reducing the cost of wintering. As a rule, good legume hays should be fed to the cows suckling calves, unless a protein concentrate such as cottonseed meal or linseed meal is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain the weight of the cattle

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc.)	6 to 8			
Nonlegume hay (grass hays, also stover)		6 to 8		
Cereal straw (oat, wheat, rye, etc.)	2 to 4	2 to 4	8 to 10	
Protein concentrate (linseed meal, cottonseed meal, etc.)		½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughage, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be determined largely by the quality of the silage. If there is little mature corn in the silage, or if the mature corn was removed before filling the silo, it is necessary to feed more silage or to supplement it with other or more nutritious feeds.

Generally good results are obtained in feeding breeding bulls half as much silage as is given to cows. A small amount of grain should be supplied in addition to the silage, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES

Calves should be fed silage only in limited quantities before they are weaned. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little weight during the weaning period when they are liberally fed on grain, legume hay, and silage. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay.

TABLE 4.—*The following rations will keep a calf weighing from 400 to 600 pounds in a thrifty, growing condition and allow considerable gain during the winter*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	15 to 20	15 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5			
Nonlegume hay (grass hays, also stover)		4 to 6		
Cereal straw (oat, wheat, etc.)			4 to 6	
Protein concentrates (linseed meal, cottonseed meal, etc.)		¼ to ½	½ to 1	¾ to 1½

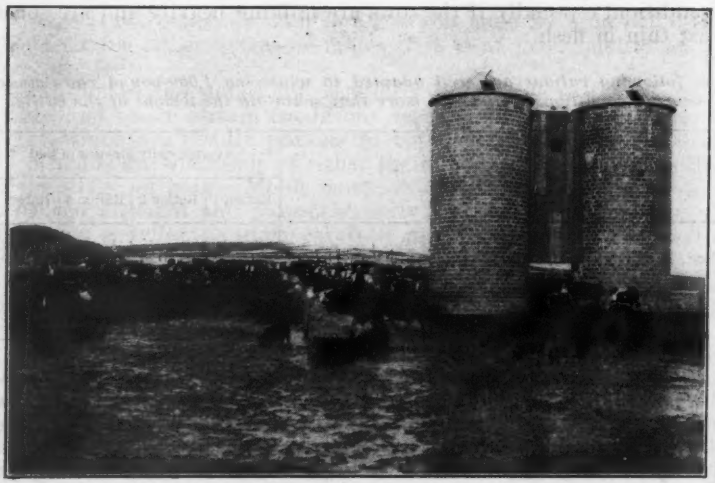

FIG. 11.—Silage is one of the best roughages for wintering the beef breeding herd

SILAGE FOR WINTERING STOCKERS

While silage is undoubtedly one of the best feeds for wintering stockers or feeders of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do cows, giving milk, or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Some, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better advantage than other cattle except, possibly, dry cows. When such silage is used it should be fed more liberally than when no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is de-

sirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price, it may be advisable to limit the dry roughage to a few pounds and increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, linseed meal, or velvet beans.

TABLE 5.—*The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4			
Nonlegume hay (grass hays, also stover)		3 to 4		
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	
Protein concentrate (cottonseed meal, linseed meal, etc.)		½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are also adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of silage fed. The dry roughages should also be increased accordingly from 2 to 3 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE

The use of silage in rations for fattening cattle varies considerably throughout the steer-feeding sections and is governed primarily by other kinds of roughage grown within the areas. In those localities where alfalfa and clover hay are produced abundantly, the use of silage for fattening beef cattle is rather limited, whereas in other areas producing grass hays or mixed hay largely silage is more extensively used. Ordinarily an abundance of cheap, dry roughage lessens the use of silage. The market value of grain also is a determining factor affecting the use of silage. When corn and other grains are high priced, their use in the ration is usually limited and the quantity of silage and protein concentrates is increased.

Experiments have shown that a certain amount of dry roughage should be fed in silage rations. Silage rations usually necessitate a longer feeding period.

TABLE 6.—*For 1,000-pound fattening animals the following average rations should be found satisfactory*

Feeds fed	Average daily amount of feed [1]				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8			1½ to 2
Nonlegume hay (grass hay, also stover)			4 to 6	6 to 8	
Protein concentrate,[2] (cottonseed meal, linseed meal, etc.)	2 to 3		3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10		

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found approximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts stated but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP

By F. R. MARSHALL (Revised by D. A. Spencer, of the Animal Husbandry Division)

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. It has been proved by different experiment stations in tests with both breeding and feeder lambs that good silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of good-quality silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be in the ration.

Silage shows the best results when fed with a good legume hay. The following has been found to be a good ration for the breeding ewe:

	Pounds
Corn silage	3 to 4
Clover or alfalfa hay	2 to 3

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable, in the latitude of the Corn Belt and the South.

SILAGE FOR LAMBS

In fattening lambs, corn silage not only saves hay and grain but reduces the cost of grains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this, offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.11

In wintering ewe lambs, silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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November 28, 1928

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Oct. 1930

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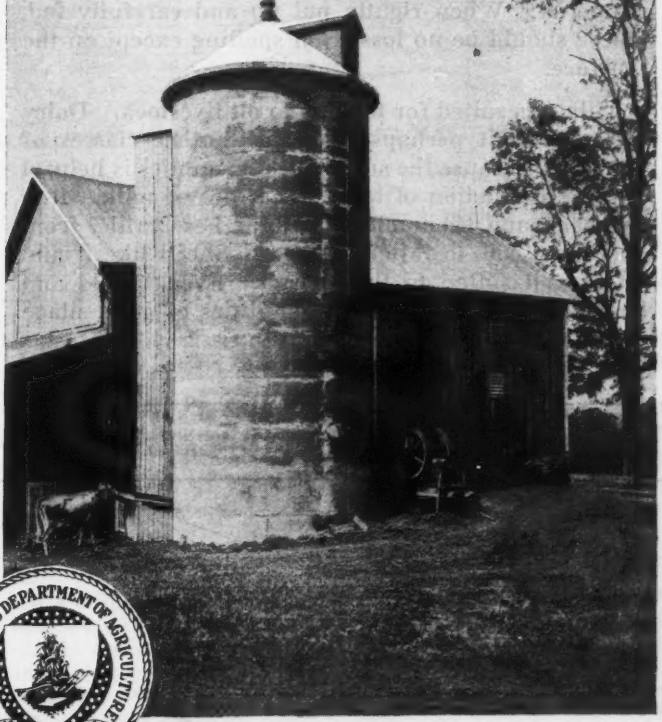
THE MAKING AND FEEDING OF SILAGE



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage; but corn, where it can be grown successfully, makes the best silage.

Good quality in the silage depends on cutting the crop at the right stage, fine cutting, thorough exclusion of air, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be no loss from spoiling except on the surface.

Silage is suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is helpful in the production of large quantities of milk. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

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THE MAKING AND FEEDING OF SILAGE

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MANUFACTURE AND FEEDING VALUE OF SILAGE

By T. E. WOODWARD and J. B. MCNULTY

SILAGE is feed that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition.

Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Livestock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, more healthy appearance than those fed exclusively on dry rations.

LOSSES OF FOOD NUTRIENTS IN THE SILO

When a crop is placed in the silo the temperature of the material rises in a few days to about blood heat and then gradually diminishes. The sugars are converted to acids, mainly lactic and acetic, which give the silage a sour taste and help to preserve it by inhibiting the

[1] Mr. McNulty resigned from the department Aug. 26, 1919, and Mr. Rommel Oct. 31, 1921.

growth of certain organisms. Normal corn silage contains about 1.5 per cent of acid.

Losses of food nutrients are due to two causes—contact with air and fermentation. The air may be excluded from the silo by proper packing of the material, by air-tight construction, and by careful attention to sealing cracks around the doors. The top of the silage is necessarily exposed to the air and will spoil, but this is the only spoiling due to air which can not be avoided. In a silo 14 feet in diameter the amount of spoiled silage on the top will be 1½ or 2 tons three months after filling.

Losses due to fermentation can not be avoided. According to the Missouri Agricultural Experiment Station [2] these losses of dry matter for various crops are as follows: Corn, 4.01 per cent; grass crops, 18.06 per cent; peas and oats, 6.90 per cent; and legume crops, 2.12 per cent.

CROPS SUITABLE FOR SILAGE

By the use of proper methods almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, legumes for example, are deficient in the fermentable constituents so desirable in the production of silage that is palatable and possesses good keeping qualities. On the other hand, a few crops, such as the sorgos, have so much sugar that unless cut at a more mature stage they have a tendency to produce a silage that is too sour.

CORN

Corn is the common silage crop wherever it can be grown successfully. (Fig. 1.) Silage made from corn has a good flavor, is very palatable, and will keep in good condition for years. It contains nearly as high a percentage of digestible nutrients as the corn from which it was made. When it is properly siloed, the losses of digestible nutrients from fermentation are smaller than in most other crops.

Throughout a considerable portion of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, loses 4.01 per cent of the dry matter as compared with 15.12 per cent when cut for fodder and cured in the field.[3] Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is practically all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite of the many strong points in favor of corn as a silage crop, however, it is not a perfect ration, because it is low in both pro-

[2] RAGSDALE, A. C., and TURNER, C. W. SILAGE INVESTIGATIONS—LOSS OF NUTRIENTS IN THE SILO AND DURING THE FIELD CURING OF CORN. Missouri Agr. Expt. Sta. Research Bul. 65, 10 p. 1924.

[3] RAGSDALE, A. C., and TURNER, C. W. Op. cit.

tein and mineral matter. In filling the silo, clover, cowpeas, soybeans, or alfalfa is sometimes mixed with corn in order to correct the deficiency of protein. Ordinarily this is not to be advised if the legumes can be made into a good quality of hay.

VARIETIES TO PLANT

As there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. Since the corn does not need to be so mature for silage as for grain, it is possible to use a later-maturing variety and thus obtain a greater yield than would be obtained from the varieties ordinarily planted for grain. At the Ohio experiment station it was found [4] that early maturing corn yielded 10.31 tons

FIG. 1.—Well-eared corn makes silage of the best quality

of silage per acre whereas late-maturing corn yielded 11.97 tons. There appears to be little if any advantage in using a variety which produces foliage and stalk at the expense of grain, as the ears contain the most valuable part of the food constituents. Ordinarily the variety of corn which produces the most grain to the acre is the best to use for silage. The greater the quantity of grain in the silage the more nutritious the silage and the greater the saving of concentrated feed used to supplement the silage.

METHODS OF PLANTING

Work at the Illinois experiment station [5] shows that thick planting results in greater tonnage and in more stalk and foliage in propor-

[4] HAYDEN, C. C. "SILAGE CORN" OR "FIELD CORN" FOR SILAGE? Ohio Agr. Expt. Sta. Mo. Bul. 8: 145–148. 1923.

[5] MORROW, G. E., and HUNT, T. F. FIELD EXPERIMENTS WITH CORN, 1890. Ill. Agr. Expt. Sta. Bul. 13: [389]–432, illus. 1891.

tion to the ears than does thin planting. When the corn is planted less than about 12 inches apart in rows from 40 to 44 inches apart on good land, the total yield of ears is decreased and the proportion of poor ears to good ears is increased. Planting more than about 12 inches apart on good land increases the proportion of good to poor ears but decreases the total weight of ears. It is thought best to space the planting so as to obtain the greatest total yield of ears. On good land this will be about 12 inches; on poorer land possibly as much as 18 inches. On weedy land it is better to plant in hills so that the corn can be cultivated both ways, in which case the planting may vary from two or three kernels in a hill to three or four kernels, depending on the fertility of the soil. The growth of weeds lowers the yield of corn, but unless weeds are present in great numbers they do not noticeably affect the quality of the silage and therefore can be cut along with the corn and put into the silo.

YIELD

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage an acre, depending on the amount of leaves and stalks that accompany the ears and on the stage of maturity at which it is siloed. The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 or 5½ bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking—that is, when about 90 per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains about 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 1 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station)[6] shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, when a large quantity of silage is made and weather conditions are unfavorable the moisture content can not be kept within these limits.

[6] LADD, E. F. REPORT OF THE CHEMIST. N. Y. State Agr. Expt. Sta. Ann. Rpt. (1889) 8: [71]–214. 1890.

TABLE 1.—*Chemical changes during growth of corn plant*

Yield per acre	Stage of growth				
	Tasseled, July 30	Silked, Aug. 9	Milk, Aug. 21	Glazed, Sept. 7	Ripe, Sept. 23
Total yield	*Pounds* 18,045.00	*Pounds* 25,745.00	*Pounds* 32,600.00	*Pounds* 32,295.00	*Pounds* 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	20,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix such corn with some which is more mature. Silage from immature corn is more sour than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible, in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without the addition of water. The frosting of the corn causes only a small decrease in feeding value, the greater part being due to the loss of leaves in handling.

DRY CORN FODDER

Sometimes there is a delay in filling the silo and it is necessary to cut and shock the corn; also, on farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out. Dry corn fodder may be siloed successfully, but it is absolutely necessary that water enough be added to make it pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower or the top of the blower pipe while filling. In addition, it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. It also lacks the aroma of good corn silage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.[7] Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

[7] ECKLES, C. H. SHOCK CORN FOR SILAGE. Missouri Agr. Expt. Sta. Circ. 71, p. 25–28, illus. 1914.

Corn stover likewise can be made into silage by the same method. It lacks flavor and palatability and is low in feeding value. It is doubtful whether the making of such silage is an economical practice.

SORGHUMS

The sorgos (saccharine sorghums), such as Amber "cane" and Orange "cane," and nonsaccharine sorghums, such as kafir, feterita, milo, Napier grass, and Sudan grass, are suitable for silage. Sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular or the soil too poor for a good growth of corn. For successful silage it is important that sorgo be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas[8] and California[9] indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

FIG. 2.—Shock corn, if properly handled, will make fair silage

LEGUMES

The legumes include the clovers, alfalfa, cowpeas, soybeans, velvet beans, and vetches. All these may be made into a good quality of silage under proper conditions. It is ordinarily a better practice, however, to make them into hay provided weather conditions permit proper curing. A crop can be preserved more cheaply as hay than as silage because of the lesser weight of water which must be handled and because of the lack of machinery adapted to the easy handling of

[8] REED, O. E., and FITCH, J. B. SORGHUM CROPS FOR SILAGE. FEEDING EXPERIMENTS WITH DAIRY CATTLE. Kans. Agr. Expt. Sta. Circ. 28, 6 p. [1913.]

[9] WOLL, F. W., and VOORHIES, E. C. TRIALS WITH CALIFORNIA SILAGE CROPS FOR DAIRY COWS. Calif. Agr. Expt. Sta. Bul. 282, p. [19]–40. 1917.

broadcast crops in the green state. Moreover, properly cured hay contains valuable vitamins that would be destroyed if the crop were put in the silo.

Legumes have a low content of sugar from which the acids so helpful in the preservation of silage are developed. For this reason greater precautions must be exercised in the making of legume silage than are necessary with the nonleguminous crops. All the legumes may be siloed successfully if mixed with a crop containing much sugar, such as corn or the sorghums; or they may be siloed alone provided the moisture content of the material is sufficiently low. When all conditions are favorable the resulting silage is palatable and the losses of food nutrients probably no greater than with corn.

At the Kansas experiment station[10] alfalfa was made into silage successfully by the addition of blackstrap molasses at the rate of 4 or 5 per cent by weight. The molasses was said to improve both the palatability and the keeping quality of the silage. At the Missouri experiment station[11] alfalfa made good silage when the moisture content of the crop ranged between 50 and 70 per cent as a result of either allowing the crop to mature sufficiently or partially drying it in the field for a few hours after mowing. On the other hand a greater moisture content resulted in ill-smelling, unpalatable silage and a considerable loss of food nutrients. Except during a period of low rainfall alfalfa at the haymaking stage usually contains too much moisture to make good silage.

The Missouri station also reports that the clovers, soybeans, and cowpeas may be made into good silage provided the moisture content is not too high. Clover for silage should be allowed to become somewhat more mature than when cut for hay. Soybeans and cowpeas should reach the stage when the seeds are well developed and the pods are beginning to turn yellow. If they have not reached this stage they should be allowed to lie in the field until thoroughly wilted.

While cowpeas and soybeans may be siloed separately, a more general practice is to use them in combination with corn or sorghum. They are grown either in separate fields or with the corn. When grown with corn cowpeas climb the stalks and make harvesting difficult. Soybeans, being self-supporting, can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soybeans make a more satisfactory crop to grow with the corn.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked. It is therefore advisable to feed legume silage immediately after milking.

SMALL GRAINS

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important

[10] REED, O. E. LATE SILAGE INVESTIGATIONS. Hoard's Dairyman 53: 322, 350, illus. 1917.

[11] ECKLES, C. H. LEGUMES, SUDAN GRASS, AND CEREAL CROPS FOR SILAGE. Missouri Agr. Expt. Sta. Bul. 162, 25 p. 1919.

to cut them fine and pack them firmly in the silo. The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

Of these crops rye especially makes a rather unpalatable silage which must be fed with care to avoid tainting the milk.

FIELD PEAS AND OATS, OR VETCH AND WHEAT

Field peas and oats or vetch and wheat planted together make a palatable silage high in protein and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut oats and peas for silage is when the oats are in the late dough stage or showing first signs of turning yellow and the pea pods are turning slightly yellow. At this time the crop contains from 30 to 40 per cent of moisture, which is the essential condition to success. If cut earlier the crop should be allowed to dry to some extent before it is placed in the silo. Probably wheat and vetch should be harvested at a similar stage of maturity. Fine cutting and thorough packing are necessary when peas and oats or wheat and vetch are siloed together.

MILLET

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are probably more profitable when used as soiling crops or as hays.

PEA VINES

Pea vines from canning factories are used for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be used until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed immediately after milking.

BEET TOPS

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it

damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches of depth increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to keep the air out. Other coarse roughage, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

CANE TOPS AND CANE BAGASSE

Tops from sugar cane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they

FIG. 3.—A corn harvester at work

are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugar cane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS

Sunflowers are used to some extent in the West and Northwest, where the weather is too cold and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that in some localities sunflowers yield a much greater tonnage than corn. As high as 29.75 tons to the acre has been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther

apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

Opinions differ as to the feeding value of sunflower silage. In some experiments it seems to be practically equal to corn silage; in others it is inferior. Doubtless the stage of maturity at harvesting time of both the sunflowers and the corn has been partly responsible for this lack of uniformity in results. A composite of all experi-

FIG. 4.—The platform cutter is adapted for use where only a small quantity of silage is to be made

ments indicates that sunflower silage is neither so palatable nor so valuable, pound for pound, as corn silage, though it may be fully equal to some of the other kinds of silage.

MISCELLANEOUS CROPS

Beet pulp, apple pomace, Russian thistle, and corn husks from canning factories are also occasionally used for silage, but in general are not so satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO

Corn or sorghums for the silo may be cut by hand, by the one-horse, two-row platform cutter (fig. 4), or by the corn harvester and binder. Hand cutting is practiced on farms where the quantity to be cut is too small to justify the purchase of a harvester and when the corn is down or in such position as to preclude the successful use of

the platform cutter or the corn harvester. Of the three methods the Nebraska experiment station[12] found that although the cost per acre of cutting corn was the lowest when the platform cutter was used, all things considered the corn harvester constituted the most satisfactory method. In case only a small quantity is to be harvested on each farm, several farmers may well cooperate in the purchase of a harvester rather than to do the work by hand.

In using the corn harvester the bundles should be made rather small. While this takes more twine, the extra expense is more than offset by the ease of handling the bundles and feeding them into the silage cutter. The harvester should not get so far ahead of the haulers that the corn will lose any considerable amount of moisture before it reaches the cutter.

A bundle elevator which is attached to the corn harvester in place of the bundle carrier has come into use in the last few years. This elevator delivers the bundles to a wagon driven alongside the harvester. Its use eliminates the hardest part of the silo-filling operation. A load of 2 tons can be put on in from 12 to 15 minutes. When

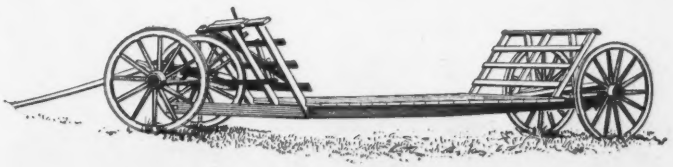

FIG. 5.—A low rack for hauling corn to cutter

the elevator is used the power necessary to pull the harvester is increased, and this fact, together with the need for a steady power, makes the use of a tractor desirable.

HAULING TO THE CUTTER

Ordinarily the corn is hauled to the cutter on a common, flat hayrack. It is best to have this rack mounted on a low-wheeled wagon, even when used in connection with a harvester and elevator. Of course, when the loading is done by hand a low-wheeled wagon is preferable to a high-wheeled one. (Figs. 5 and 6.)

A low rack or body can be made easily. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, Cost of Filling Silos:[13]

> The rack . . . consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. . . . The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

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[12] CHASE, L. W., and WOOD, I. D. HANDLING SILAGE. Nebr. Agr. Expt. Sta. Bul. 145, 25 p., illus. 1914.

[13] CARRIER, L. COST OF FILLING SILOS. U. S. Dept. Agr. Farmers' Bul. 292, 15 p., illus. 1907.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading and facilitating the work of unloading.

CUTTING THE SILAGE

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are whether or not it is strongly made and will cut fine. The capacity is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that everyone will be able to keep busy

FIG. 6.—Loading corn on the wagon, the hardest work of all

all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes often lack. Other factors to be taken into account are the amount of work to be done and the power to be used.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand, the longer the pieces the more rapidly the corn can be run through the cutter. Probably most silage is now cut into pieces about half an inch long.

ELEVATING THE SILAGE

Two types of elevators are in use, the old-style chain carrier and the blower. The chain carrier requires less power but is harder to set up and is not so well adapted for high silos. Some chain carriers are inclosed so as to keep the corn from blowing out. In using the blower type the blower should be as nearly perpendicular as possible (fig. 7) to reduce to the minimum the friction of the cut corn on the inside of the pipe and thus lessen the danger of clogging.

If it is impossible to place the silage cutter close to the silo, it is well to keep the blower pipe nearly vertical but to extend it high enough so that the cut corn from the top of the pipe will run into the silo at an angle of about 45°.

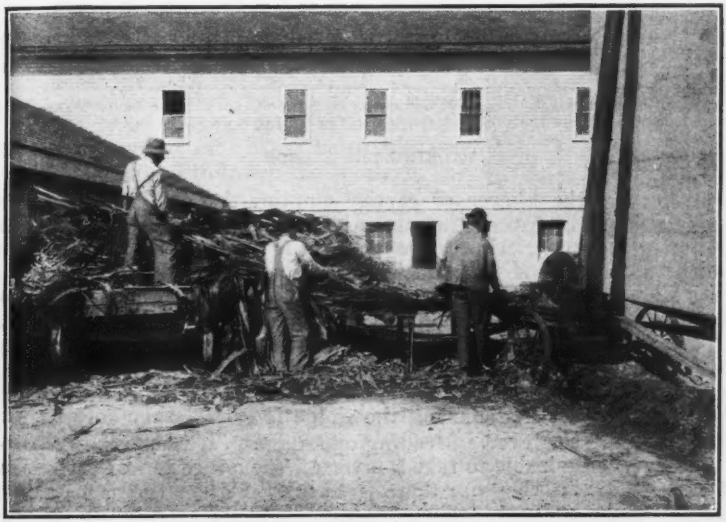

FIG. 7.—Silage cutter with blower

POWER REQUIRED

The power necessary to operate the cutter depends on width of cutter throat, sharpness of knives, type of elevator, height of silo, rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed below full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. The figures in Table 2 represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. This table has been prepared from manufacturers' statements, personal observations, and experience, and is not the result of actual experimental tests.

TABLE 2.—*Horsepower (gas engine) required to operate silage cutter and blower, with varying widths of cutter throat and varying heights of silos*

Width of cutter throat	Height of silo—feet														Approximate capacity
	24	26	28	30	32	34	36	38	40	42	44	46	48	50	
	Horsepower														
															Tons per hour
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	19
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	9

If a steam engine is used the horsepower ratings may be 25 per cent less than the figures above. If an electric motor is used the rated horsepower can be 15 per cent less than the figures in the table.

PACKING THE SILAGE

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless the material is distributed the leaves are blown to one side of the silo. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. Recent experiments at the experiment station of the Bureau of Dairy Industry at Beltsville, Md., show that tramping may be entirely dispensed with. The experiments show also that if the corn is put in the silo at the proper stage of maturity, distributing the silage is unnecessary for perfect preservation. However, in feeding out silage which has not been distributed, it is desirable to take a layer off the entire top of the silage at each feeding; otherwise there is likelihood of getting a batch of silage which contains a preponderance of either leaves or the heavier constituents of the corn plant.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being flexible (fig. 8) can be swung so as to place the material anywhere in the silo. With this contrivance it is not necessary to handle the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some object which may be blown up the blower pipe. As the silage rises in the silo the distributor pipe, which is put together in sections, can be readily shortened.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless the silage is well packed, air will enter and mold will develop. Enough water should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied by means of a hose and spray nozzle, directly on the silage in the silo as it is filled; or it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full and has been leveled off. This helps to pack the top layer and to lessen the spoilage.

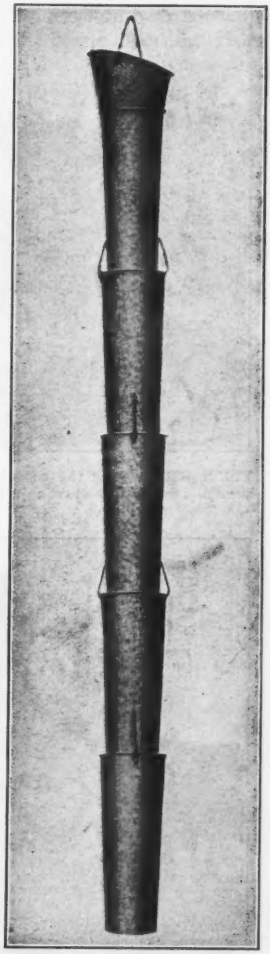

FIG. 8.—Jointed-pipe silage distributor

RONNING METHOD OF MAKING SILAGE

The Ronning method of silo filling has been used to some extent in the last few years. The standing corn is harvested and cut into proper lengths for the silo by a machine drawn by a tractor and operated by means of power from the tractor. (Fig. 9.) The cut corn is delivered to a wagon box drawn alongside. It is then hauled to the silo and pushed off into a blower which elevates it into the silo. (Fig. 10.) With a pit silo the material can be dumped directly into the silo. This method of making silage is the easiest known. It is about as rapid and requires approximately the same size crew as when a harvester and bundle elevator are used. It is easier, however, because the labor of placing the bundles in the wagon is saved and because pushing the cut material into the blower is easier than throwing the corn bundles into the cutter. It is probable, also that the Ronning outfit will operate successfully on softer ground than will the harvester and elevator on account of the mechanism being operated by power from the tractor. A disadvantage of the Ronning system is that the corn may be blown down so that hand cutting must be resorted to, in which case the ordinary kind of silage cutter must be used.

COVERING THE SILAGE

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer

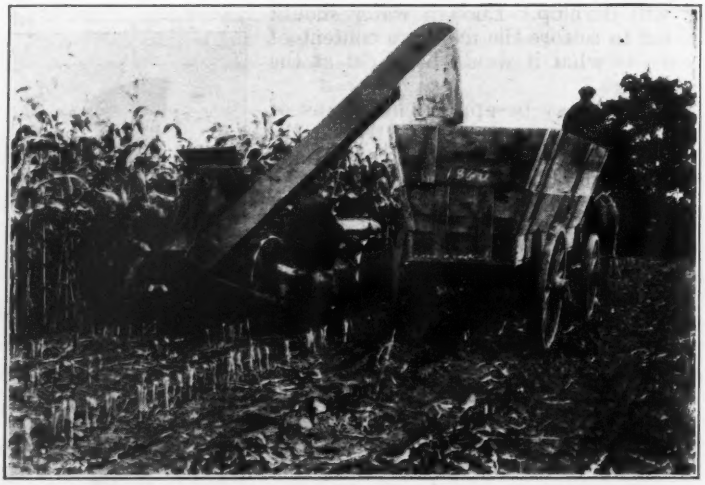

FIG. 9.—Harvesting the corn by the Ronning method. (Courtesy of Central Experiment Farm, Ottawa, Canada)

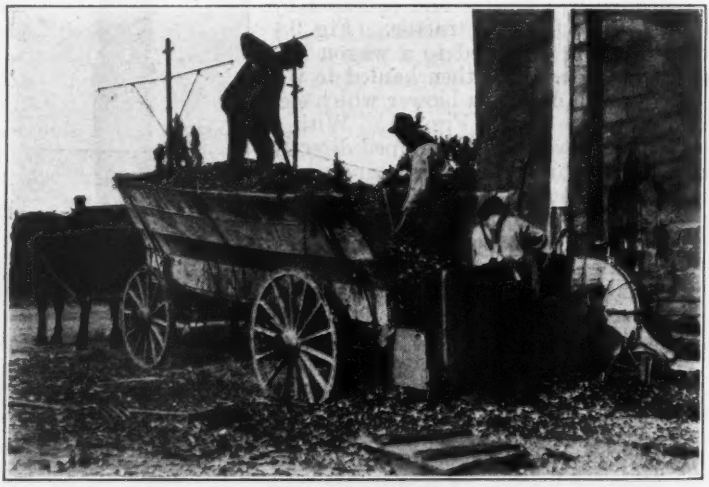

FIG. 10.—Transferring the cut corn to the silo by the Ronning method. (Courtesy of Central Experiment Farm, Ottawa, Canada)

from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack

much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to keep the air out of the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled. If this is done, no covering is necessary and there should be no loss on account of spoiling.

FEEDING VALUE OF SILAGE

COMPOSITION

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. (Table 3.)

TABLE 3.—*Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds*

(From Feeds and Feeding, by Henry and Morrison) [1]

Crop	Total dry matter	Digestible dry matter			True protein	Net energy value
		Crude protein	Carbohydrates	Fat		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Therms*
Green-corn fodder	21.9	1.0	12.8	0.4	0.8	14.60
Corn silage	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder, sweet	24.9	.7	14.8	.7	.4	15.37
Sorghum silage, sweet	22.8	.6	11.6	.5		
Uncured red clover	26.2	2.7	13.0	.6	1.7	15.87
Clover silage	24.4	2.0	9.6	.8	.8	7.26
Uncured soybeans	23.6	3.2	10.2	.5	2.4	12.53
Soybean silage	27.2	2.8	10.8	.9	1.5	11.59
Uncured cowpeas	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage	21.2	1.8	9.7	.5	1.1	11.05
Uncured oats and peas	22.6	2.4	10.6	.6		
Mangels	9.4	.8	6.4	.1	.1	5.68
Sugar beets	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet)	9.3	.5	6.5	.2	.5	8.99
Prickly pear	16.5	.4	8.9	.2		
Sunflower silage	21.9	1.0	9.8	.8		

[1] HENRY, W. A., and MORRISON, F. B. FEEDS AND FEEDING. Ed. 18, unabridged, 770 p., illus. Madison, Wis. 1923.

PALATABILITY

Palatability is of much importance because it induces a large consumption and because it stimulates the secretion of digestive juices. No rough feed is more palatable than good corn silage. Cows nearly always eat silage in preference to hay. If any of the ration is refused it is more often the hay than the silage.

SILAGE FOR DAIRY CATTLE

By T. E. WOODWARD and J. B. MCNULTY

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous on farms devoted to dairying than on any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for winter feed.

SUPPLEMENTARY FEEDS

Although corn silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be fed with some leguminous hay, such as clover, soybeans, or alfalfa. These supply the deficiencies of silage in protein and mineral constituents. However, a ration of silage and hay alone is still too bulky to be satisfactory for other than dry cows or those giving not more than a medium quantity of milk. Under most conditions cows can not consume enough of these two feeds to support a liberal flow of milk and maintain their body weight. They must have some concentrated feed.

RATIONS

A good rule to follow in the feeding of silage is to allow each cow about 3 pounds of silage a day for each 100 pounds of live weight. For example, give an 800-pound cow 24 pounds of silage, a 1,200-pound cow 36 pounds of silage, and so on. Along with this give the cow all the hay that she will eat. The quantity of grain to feed depends on a number of factors, chief of which are quantity and quality of milk yield and kind and quality of hay fed. The quantity of silage stated above and all the good legume hay the cow will eat twice a day will support a milk yield of from 10 to 16 pounds, depending on the richness of the milk. Consequently a cow giving these quantities requires no grain. For the production of milk above these quantities the nutrients must be provided in the grain. About 0.4 pound of grain is required to provide the nutrients for the production of 1 pound of milk testing 3.5 per cent or less butterfat, 0.5 pound for milk of medium richness testing 4 to 4.5 per cent, and about 0.6 pound for milk testing more than 5 per cent. For example, if a cow is giving 25 pounds of milk testing more than 5 per cent, 10 pounds of this will be provided for by the roughage, whereas 15 pounds must be provided for by the grain. The quantity of grain needed, therefore, is 15×0.6 pound, or 9 pounds. If a cow is giving 36 pounds of milk testing 3.5 per cent or less, 20 pounds must be provided for by the grain. The quantity of grain needed for this cow, therefore, is 20×0.4 pound, or 8 pounds. Coarse or poorly cured hay is not consumed in such great quantities as good legume hay. Consequently when inferior hay is fed the grain allowance must be increased.

TIME TO FEED

Corn silage usually affects the flavor and odor of milk unless fed either just after milking or several hours before. It is generally fed twice a day.[14]

RATE OF FEEDING

When silage is exposed to the air in warm weather it spoils quickly. For this reason a uniform layer should be removed from the top every

[14] GAMBLE, J. A., and KELLY, E. THE EFFECT OF SILAGE ON THE FLAVOR AND ODOR OF MILK. U. S. Dept. Agr. Bul. 1097, 24 p., illus. 1922.

day. In summer this layer should be not less than 3 inches thick but during cold weather feeding may be as slow as desired. Except for some drying on the surface, silage from which the top had been fed has been known to keep in perfect condition for a month or longer in winter.

As a means of preventing loss from surface spoilage the Missouri Agricultural Experiment Station uses and recommends a canvas covering, treated with hot paraffin to make it air-tight. This covering is stretched tightly on a circular iron frame over the silage to within half an inch of the walls. By means of a pulley and rope the canvas can be raised or lowered.

FEEDING FROZEN SILAGE

Frozen silage must be thawed before using, after which it should be fed immediately, before decomposition sets in. No harm will result from feeding, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS

Although silage has been fed successfully to vigorous young calves as soon as they would eat it and in as large quantities as they would consume, there is some evidence that it should be omitted from the ration until the danger of serious digestive disturbance is past, say 60 days, after which it may be fed safely in quantities up to the capacity of the calf. Yearling heifers consume about half as much as mature stock, that is, from 12 to 24 pounds a day if they are well grown. When supplemented with some good leguminous hay, little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds a day for each 1,000 pounds of live weight. When fed in this quantity, silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

When cows are dry they consume almost as much roughage as when they are producing milk. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 40 pounds of silage and from 5 to 8 pounds a day of clover, soybean, or alfalfa hay—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive some grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed. Later in the fall it is impossible to restore the

milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. How much to feed depends on the condition of the pastures, the quantity varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES AND MULES

By GEORGE M. ROMMEL (Revised by J. O. Williams, of the Animal Husbandry Division)

Silage is not generally used in horse and mule feeding, but it is a safe feed for either horses or mules if it is of good quality and is carefully fed.

Both horses and mules are peculiarly susceptible to the effects of molds, and under certain conditions varieties of molds are found in silage which are deadly poisons to both of these classes of stock. If the feeder watches the silage carefully as the weather becomes warm, he can soon detect the presence of mold. When mold appears, the feeding should be stopped immediately. Similarly, care should be exercised in the winter feeding of silage so that horses or mules are not allowed to eat frozen silage, because of the danger of colic.

Corn silage is the only kind that so far has met with any degree of favor as a horse or mule feed. Corn which is to be ensiled for this purpose should not be cut too green, as sour silage will result, and this may cause colic when fed. Corn for such feed, rather, should be cut when most of the kernels have passed beyond the milk stage.

Silage should not be considered as the principal roughage for horses and mules, but should serve as a partial substitute for hay in the daily ration. Because of its bulky nature, horses and mules doing hard work should not be fed large quantities, but, owing to its tonic, laxative, and appetizing effects, it is well suited for the maintenance of idle horses and mules, brood mares, and growing stock. The value of silage is greatest, in the case of horses and mules, as a means to carry them through the winter cheaply or to supplement pasture during periods of drought. When used, silage should be introduced gradually into the ration, and the amount fed should generally not exceed from 10 to 15 pounds daily per animal.

SILAGE FOR BEEF CATTLE

By E. W. SHEETS

SILAGE FOR THE BREEDING HERD

Silage, when available, should form the principal part of the winter ration for the breeding herd. (Fig. 11.) Cows and calves relish it and thrive on it when some supplement is added. Silage in the ration creates an appetite for cheaper and less palatable roughages, thus reducing the cost of wintering. As a rule, good legume hays should be fed to the cows suckling calves, unless a protein concentrate such as cottonseed meal or linseed meal is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain the weight of the cattle

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	25 to 30	35 to 40
Legume hay (clover, alfalfa, etc.)	6 to 8			
Nonlegume hay (grass hays, also stover)		6 to 8		
Cereal straw (oat, wheat, rye, etc.)	2 to 4	2 to 4	8 to 10	
Protein concentrate (linseed meal, cottonseed meal, etc.)		½ to 1	1 to 2	1½ to 2½

For dry cows, silage and cheap roughage, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be determined largely by the quality of the silage. If there is little mature corn in the silage, or if the mature corn was removed before filling the silo, it is necessary to feed more silage or to supplement it with other or more nutritious feeds.

Generally good results are obtained in feeding breeding bulls half as much silage as is given to cows. A small amount of grain should be supplied in addition to the silage, depending on the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES

Calves should be fed silage only in limited quantities before they are weaned. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little weight during the weaning period when they are liberally fed on grain, legume hay, and silage. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay.

TABLE 4.—*The following rations will keep a calf weighing from 400 to 600 pounds in a thrifty, growing condition and allow considerable gain during the winter*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	15 to 20	10 to 20	15 to 20	20 to 25
Legume hay (clover, alfalfa, etc.)	2 to 5			
Nonlegume hay (grass hays, also stover)		4 to 6		
Cereal straw (oat, wheat, etc.)			4 to 6	
Protein concentrates (linseed meal, cottonseed meal, etc.)		¼ to ½	½ to 1	¾ to 1½

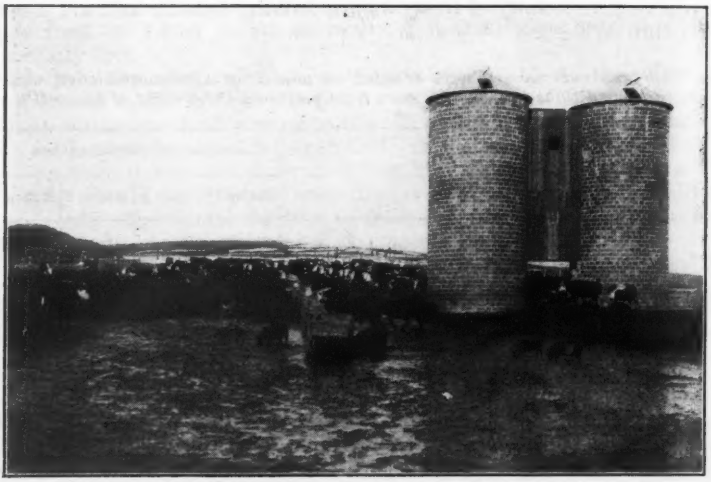

FIG. 11.—Silage is one of the best roughages for wintering the beef breeding herd

SILAGE FOR WINTERING STOCKERS

While silage is undoubtedly one of the best feeds for wintering stockers or feeders of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do cows, giving milk, or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better advantage than other cattle except, possibly, dry cows. When such silage is used it should be fed more liberally than when no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is de-

sirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price, it may be advisable to limit the dry roughage to a few pounds and increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, linseed meal, or velvet beans.

TABLE 5.—*The following rations are usually satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	20 to 25	20 to 25	20 to 25	25 to 35
Legume hay (clover, alfalfa, etc.)	3 to 4			
Nonlegume hay (grass hays, also stover)		3 to 4		
Cereal straw (oat, wheat, etc.)	2 to 4	2 to 4	6 to 8	
Protein concentrate (cottonseed meal, linseed meal, etc.)		½ to 1	½ to 1	1 to 2

The rations suggested for yearlings are also adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending on their size and condition as well as the quality of silage fed. The dry roughages should also be increased accordingly from 2 to 3 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE

The use of silage in rations for fattening cattle varies considerably throughout the steer-feeding sections and is governed primarily by other kinds of roughage grown within the areas. In those localities where alfalfa and clover hay are produced abundantly, the use of silage for fattening beef cattle is rather limited, whereas in other areas producing grass hays or mixed hay largely silage is more extensively used. Ordinarily an abundance of cheap, dry roughage lessens the use of silage. The market value of grain also is a determining factor affecting the use of silage. When corn and other grains are high priced, their use in the ration is usually limited and the quantity of silage and protein concentrates is increased.

Experiments have shown that a certain amount of dry roughage should be fed in silage rations. Silage rations usually necessitate a longer feeding period.

TABLE 6.—*For 1,000-pound fattening animals the following average rations should be found satisfactory*

Feeds fed	Average daily amount of feed [1]				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Silage	25 to 30	25 to 30	30 to 35	30 to 35	45 to 50
Legume hay (clover, alfalfa, etc.)	1 to 2	6 to 8			1½ to 2
Nonlegume hay (grass hay, also stover)			4 to 6	6 to 8	
Protein concentrate,[2] (cottonseed meal, linseed meal, etc.)	2 to 3		3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear)	12 to 14	14 to 15	8 to 10		

[1] The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

[2] Where velvet beans (in pods) are used, 2½ pounds will be found approximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts stated but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP

By F. R. MARSHALL (Revised by D. A. Spencer, of the Animal Husbandry Division)

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. It has been proved by different experiment stations in tests with both breeding and feeder lambs that good silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of good-quality silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be in the ration.

Silage shows the best results when fed with a good legume hay. The following has been found to be a good ration for the breeding ewe:

	Pounds
Corn silage	3 to 4
Clover or alfalfa hay	2 to 3

Toward the end of the period of pregnancy it is well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable, in the latitude of the Corn Belt and the South.

SILAGE FOR LAMBS

In fattening lambs, corn silage not only saves hay and grain but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this, offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds
Grain (shelled corn, 4 parts, cottonseed meal, 1 part)	1.1
Corn silage	1.38
Clover hay	1.11

In wintering ewe lambs, silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

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